EDITORIAL

THE Supreme Court of California has reversed its former decision in the case of the Oro Electric Corporation, and finds that no rights of the city of Stockton were impaired by the Railroad Commission's refusal to grant the Company a certificate to operate in the city. The history of the case goes back to April 1913, when the Oro Electric Company, having received a franchise from the city, applied to the Commission for a certificate of convenience and necessity. The Commission allowed the Company a certificate to serve most of the adjacent country, but held that the city itself would be adequately served by the Western States Gas & Electric Company upon the completion by it of certain additional work. When the case was first appealed by the Company, the Commission, in stating its side, did not question the power of the city to grant franchises for the distribution and sale of electricity, but in the rehearing this point was brought up, and the Court found no evidence to show that at the time of the granting of the franchise the city possessed such powers over public utilities. On this point alone, the former decision was reversed.

IN the case of the United States *v.* The Midwest Oil Company, the Supreme Court has sustained the validity of President Taft's withdrawal order of September 27, 1909. While the land concerned in the case at issue was situated in Wyoming, the legal questions involved were the same as for the California cases, and the decision, therefore, reverses that of Judge Dooling, delivered last June, in the Midway Northern Oil Company case. The area of actual oil land in California affected by this decision is not so great as is popularly supposed. Outside of the Midway and Sunset fields there is very little land, on which operations are now being carried on, that is not already patented, and much of the land in those fields is in the same category. On a large portion of the remaining lands, either actual discovery of oil had been made or bona fide operations toward such a discovery were being carried on at the time the withdrawal order was issued. Operators on such lands come within the classes especially protected under the provisions of the Pickett bill. It is hardly likely that any worse fate will befall them than the refusal of their patents and a continuation of operations under a leasing system. It is significant in this regard that none of these operators has been made the defendant in the suits recently brought by the government to test the validity of the withdrawal order. Those operators who commenced to drill on withdrawn land after September 27, 1909, may not only be dispossessed, but also be obliged to pay for the oil that they have extracted and sold. The only hope for this class of operators lies in the possibility of 'remedial legislation' by Congress. In this regard, it may be noted that the chances for the passage of such legislation before the regular session of Congress convenes next December are slight.

WHILE a newly settled community or business enterprise is sometimes obliged through lack of immediate funds to make use of temporary construction, sound business principles, and frequently considerations of safety as well, demand that such temporary works shall be replaced by those of a permanent character as soon as possible. Unfortunately, makeshifts of many kinds are frequently erected when there is no real excuse for not doing the work right at the start. Many engineers, ground between the upper millstone of an inadequate appropriation and the lower one of public demand for individual benefit, attempt, say, to spread over fifty blocks a street appropriation which would have provided good pavement on ten, with the result that the public money is exhausted with little or no real benefit. The fate of the man in the parable who persisted in the use of temporary construction on the sand is familiar to us all. Something like this happened in southern California during the recent storms. At several of the beach resorts, temporary piers and bulkheads were undermined and 'great was the fall thereof.' On the other hand, the new municipal pier of reinforced concrete at Santa Monica was undamaged, despite the battering, not only of the waves, but also of floating piles from other piers which had not weathered the storm so well.

BILLS have been introduced in the California legislature by Assemblyman Harris of Bakersfield, declaring the production, transportation, refining, and marketing of oil to be a public utility, under the jurisdiction of the Railroad Commission. The Commission is endowed with similar powers as to rates that it already possesses with respect to ordinary public utilities. Anyone wishing to construct a new well, pipeline, refinery, or distributing plant must apply to the Commission for a certificate of public convenience and necessity. When the amount of oil in storage in the state exceeds fifty million barrels, no more certificates for the drilling of new wells are to be issued until the storage falls below that figure, then only for enough wells to increase the storage to that amount as nearly as can be determined. Another bill prohibits common carrier railroads from engaging in any branch of the

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oil business or holding stock in companies engaged in the business. It also prohibits any person or company engaged in any other branch of the oil business from engaging in the sale of oil-well supplies. While it may be conceded that these bills will be considerably modified before becoming laws, and may fail of passage altogether, it is significant that there should be considerable demand for such measures among those engaged in so highly individualized an industry as the oil business has been heretofore. It is also a little unusual that the main demand for public regulation should come from those inside rather than those outside the industry.

SPECIFICATIONS for street work in San Francisco have been amended to allow the use of concrete pavement outside the district where concrete curbs are prohibited, and where the grades do not exceed 15 per cent. A special permit may also be granted for such pavement on any street or alley.

OF several bills now before the California legislature for establishing a degree of state control over county highways, the most important is that introduced by Senator Mott. The Mott bill provides, in brief, for the creation of a division of county highways in the state department of engineering, the head of which is to be appointed by the state engineer. The latter official is also to appoint a highway engineer for each county, except that any two of the smaller counties may be combined under one engineer. The county surveyor may be appointed county highway engineer, in cases where his qualifications are up to a certain standard of experience on road construction. The highway engineer, upon request of the county board of supervisors, is to prepare plans for public works in the county and have charge of their construction, except in the case of buildings requiring the services of an architect. He is also to act as adviser to the board of supervisors in questions regarding public works and shall have charge of equipment and supplies used thereon. The supervisors are to retain their general administrative powers over roads and other public work, and the individual supervisors are given the choice of either retaining complete supervision over bridge expenditures under $500 and road expenditures under $300, or of turning them over to the highway engineer together with the more important public works. The state highway engineer is to act in a general consulting and advisory capacity to both the county engineers and the boards of supervisors. Time alone will tell whether such a bill would accomplish the professed object of taking the county highways out of politics, or whether it would simply transfer them from county politics to state politics. Even if many traces of political influence remained, however, there would be a great improvement over the present system through the provision for supervision by trained men, and improved opportunities for correlation of experience and standardization of procedure in both construction and maintenance. Those who oppose all measures extending the authority of the state over what have been heretofore considered purely county affairs should think twice before arbitrarily opposing this or similar bills. A law turning the entire control of county highways over to the State Highway Commission is well within the bounds of possibility.

CONSIDERATION of the general question of the administration of county public works brings to mind the possibility of extending the 'city manager' idea to deal with county affairs as well. The duties of the executive officers of a county are essentially similar to those of a city. It should be possible to select a capable man for 'county manager,' who would be able to effect a number of improvements in the administration of the affairs of almost any county. In a county with a population of three or four thousand, it is probable that, with some purely clerical assistance, and perhaps an occasional call upon outside expert advice, one man could handle all the work now done by the several executive officers and do it better. Whatever the size of the county, there is often considerable loss in efficiency because of divided responsibility and also because of jealousies between the various departments. Centralization of authority and responsibility would do a great deal toward eliminating this condition.

AT the annual meeting of the American Society of Civil Engineers in New York during January there was held a conference of presidents of the local associations. There is already before the Society an amendment providing for an increase in the number of districts from seven to thirteen, and a change in the manner of representation. Assuming that this amendment will be adopted, the conference recommended the adoption of further amendments creating an organization in each of the new districts, whose necessary expenses shall be paid out of the funds of the parent society, and which shall have the usual officers. Beyond a certain rather nebulous authority to deal with local matters, it is not clear just what these officers will have to do. Except when the Board of Direction shall have reason to decide otherwise, the annual convention of the parent society is to be held in each district in turn. Local sections are recognized, but otherwise are left very much as they have been in the past. They may affiliate with other local technical organizations, but must not, as a body, take action on any matter with such organizations. There has been more or less unfavorable criticism of the Society in the past, as compared with the other national engineering societies, because the local organizations were not given sufficient attention, and New York members appeared to receive an undue share of the benefits of the Society. It is believed by advocates of the proposed amendments that they will have a tendency to remedy this condition.

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REVIEW OF THE MONTH

HERE in San Francisco the opening of the Panama-Pacific Exposition on February 20 overshadowed all other events of the month. In point of attendance all records have been broken. The total for the first week is estimated at approximately 680,000. For the first week in Chicago the figure was 257,036, and for the first week at St. Louis 325,144. The comparison is more striking when it is taken into consideration that February is mid-winter in California, while both the Chicago and St. Louis expositions did not open until winter was over and spring had come. The heavy rains during the first week of the Exposition seem to have promoted rather than dampened the ardor of the thousands of enthusiasts who have wondered at the many marvels displayed.

ONE San Franciscan who had tramped about the grounds during the entire opening day and night and stood looking at the Tower of Jewels, reluctant to come away, turned to a friend and remarked: "You may tell me anything you please about this Fair and I will believe it." A middle-aged woman, evidently from somewhere in the interior of the state, was heard to remark while passing out by one of the numerous exits: "I have been here since nine this morning and I don't believe I have seen half of it." In view of the fact that there are 42 miles of aisles in the main exhibit palaces alone, seeing half of the Exposition in one day is rather a good record. For our own part, we are willing to confess to an almost equally inadequate conception of the extent and greatness of the Exposition. For example, we had planned to publish in each issue a summary of the daily program for the benefit of our readers outside of San Francisco. After going into the matter, it soon became evident that in order to accomplish this result there would be no space left for any other purpose; even the advertising section would have had to be sacrificed. In the vernacular of the street, there is 'something doing' from early morning to dewy eve, and apart from the more serious and instructive phases of the Exposition, we can only say that the Zone to be appreciated needs but to be seen.

WHILE popular opinion has, by common consent, awarded to the city of Los Angeles the palm for being the most consistently harmonious city in the United States, recent criticism of the aqueduct indicates that the external appearance of brotherly love and co-operation is perhaps due more to the tightness with which the lid is clamped down than the absence of disturbance in the pot itself. The local papers in Los Angeles, and especially the dailies, seem to have a settled policy of publishing nothing concerning the aqueduct that is not good. Occasionally, however, fragments of vigorous criticism will get by the censor and be made public through other channels. It is known, of course, that the aqueduct and its affairs have been investigated a number of times, and it is also conceded that none of these investigations has resulted in material benefit. In fact, the motive behind the investigations appears to have been that of politics and of destructive rather than constructive criticism. The latest turn that aqueduct affairs have taken is in the form of some very serious allegations as to the fitness of the water for domestic purposes. This overshadows in importance any of the criticisms that have been made before, and it would appear to be the part of wisdom that the citizens of Los Angeles take steps to correct the impression that has been conveyed that the aqueduct water is not what it should be. It has been charged that the source of the Owens River water is polluted by seepage and also by sewage from towns and private residences along the river, and that garbage dumps and other unsavory things contribute to the pollution and the consequent danger to domestic consumers from typhoid and other diseases.

A SUIT is now under way in Los Angeles in which an attempt is being made to establish in court that the water is impure and not fit to use. It would appear to us that the most disquieting feature of the entire controversy is the tendency on the part of the newspapers and others in Los Angeles to suppress the facts. This in itself would indicate that there is more importance to be attached to the charges than most of us have given to them in the past. It is one thing to allege poor engineering or defective workmanship, and another thing to charge that water for domestic consumption that has cost some $25,000,000 to conduct to a great city is so polluted as to threaten an epidemic of fatal disease. We believe that the attitude of the Los Angeles administration in attempting to minimize the evidence that has been introduced by the critics to be totally wrong. We believe that it is the duty of the city officials to ascertain the truth in such a way as to leave no shadow of doubt that it is the truth, and then make it public and settle the entire matter once and for all time.

THE aqueduct project is one in which the entire Pacific Coast, and in fact the United States, took the greatest interest and pride. Its construction should stand as a monument to the enterprise and superlative energies of the citizens of Los Angeles. Other sections of California and of the Pacific Coast feel a genuinely

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friendly interest in the well-being of the metropolis of the south and cannot fail to suffer in a great measure for anything that may injure or retard its growth. The city of Los Angeles owes it to itself and all of its citizens to undertake at once a thorough sanitary survey, made by impartial experts of acknowledged standing. These experts should under no circumstances be citizens or residents of the Pacific Coast, but should be brought from a section of the country sufficiently remote from Los Angeles and its internal politics as to be absolutely free of bias in favor of one side or the other. It is probably true that even if the water were contaminated to the extent that is charged, its purification could be accomplished and would be a relatively small matter when the big questions in connection with any public water-supply are taken into account. We do not believe for a minute that the aqueduct is a failure, or that it is going to prove to be a failure. We also do not believe that any contamination which may exist in the water is of so great a magnitude that it cannot be overcome or neutralized by a water purification plant if necessary. We do believe, however, that suspicion that all is not as it should be is being fostered rather than stilled by suppressing the news and attempting to controvert the evidence offered by personal attacks upon the character or standing of witnesses.

IT is unfortunate, however, that so many of the aqueduct critics, in their attempts to discredit anything and everything that has been done, should deem it necessary to go outside of the field of the aqueduct proper in their attempts to find something wrong. One of our contemporaries last January published a general article criticizing certain features of the aqueduct construction. As an instance of the alleged incompetence of the aqueduct management is cited the use of the caterpillar tractor. We quote: "It took only a few months to show the impracticability of handling freight by this method, and the caterpillar engines were junk after the city had sustained losses running into hundreds of thousands of dollars." As a matter of fact, the caterpillar tractor was carefully investigated by the mechanical engineers of the aqueduct organization, and, after their recommendation to purchase, two of these tractors were bought on trial and were run for a period of about three months, giving good satisfaction, particularly in the handling of large and bulky equipment.

FOLLOWING the success of the first two machines, some 27 or 28 were purchased and operated for between two and three years. According to the official reports of the Bureau of November 30, 1908, it is stated that work in the Jawbone and Mojave sections showed an average cost per ton-mile of 20 cents, as compared to an average of 40 to 50 cents for team transportation on the same roads under similar conditions. The lowest bid received from outside teamsters for this hauling was 80 cents per ton-mile. When the greater part of the heaviest hauling had been completed, the tractor equipment, after having had from two to three years of the hardest kind of service, was not junk as charged, but was re-sold and most of these machines are doing good service today.

ANY engineer knows that there are conceivable conditions under which hauling by mule teams is cheaper than hauling by tractors, and *vice versa*. So far as we can ascertain from reports in existence and from correspondence with aqueduct officials, the tractors were bought for a certain specific purpose; that for between two to three years they answered that purpose most acceptably; that when their work was accomplished they were disposed of. If a man wishes to travel a distance of a few hundred feet, it is probably cheaper for him to walk than to hire an automobile. If a man desires to travel from San Francisco to New York, however, we question whether it would pay him to walk if time were an element of any consequence. This, in a few words, seems to have been the situation in comparing tractor and mule-team haulage. With two or three years of use for, say, 28 tractors, and a saving of approximately 50 cents per ton-mile during that period, it would appear that, had it been necessary, the aqueduct officials might well have afforded to scrap their tractors and disregard the item of salvage that might have been recovered through re-sale. It appears to us to have been unfair to discredit the aqueduct management by attacking a machine of well known efficiency that has become practically an established standard wherever mechanical hauling is employed.

ON Wednesday evening, January 27, the inaugural exercises of The Engineering Foundation were held in the auditorium of the Engineering Societies Building, 29 West 39th street, New York. At this time the initial gift to the Foundation of $200,000, made by Ambrose Swasey, was formally accepted. A board of eleven members, two each from the four great engineering societies, and two from the world at large, together with the president of the United Engineering Society, will be selected to administer the Foundation. Mr. Swasey has modestly and wisely refrained from making any stipulation as to the method of applying his gift, and the Board has not as yet made a statement in this regard. Suggestions as to the disposition of the income from the Foundation which have been received from many prominent engineers, are naturally of a varied character. There is considerable demand for research work, in some cases the particular subject being specified. Other engineers feel that the need is not so much for more research, as for a proper co-ordination and direction of that now being carried on. Similar to this latter desire is the wish for a truly comprehensive engineering digest published at frequent intervals, which would make available all the information obtainable on any engineering subject. Many others are in favor of scholarships.

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Concrete Pavement Construction on Oregon State Highways

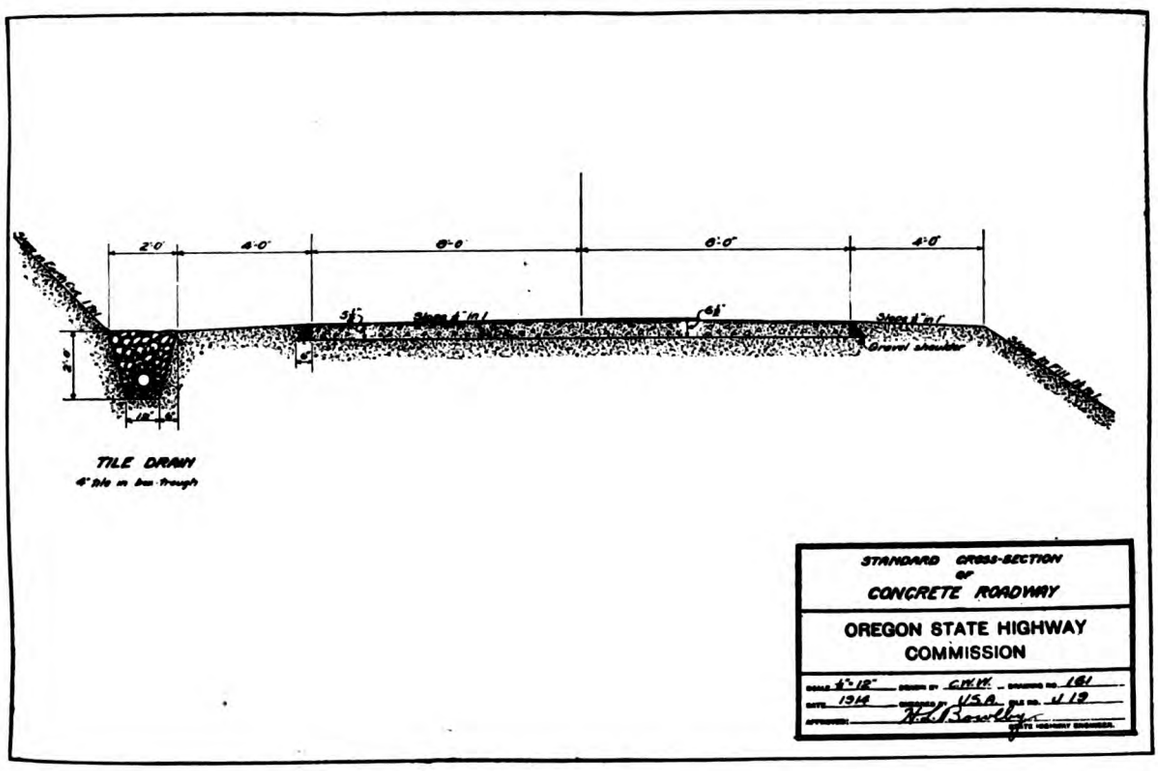
The Oregon State Highway Department was created by the Legislature at the session of 1913, Henry L. Bowlby being appointed state highway engineer. His first annual report for the period ended November 30, 1914, has recently been issued, and contains much interesting matter. Probably the most valuable feature of the report is the large amount of data concerning the use of concrete pavement in the construction of the system of state highways.

In Jackson county, a stretch of road 9.5 miles long between Talent and Central Point, was improved with a two-course concrete pavement, 16 ft. wide. The base was four to four and a half inches at the sides and one inch thicker at the centre. Most of the coarse aggregate was granite from a neighboring quarry, although some creek gravel was also used. Several different mixtures were used, ranging from one part cement and six parts aggregate to one part cement and eight parts aggregate. On the first two miles of pavement, the wearing surface was composed of one part cement to two parts granite chips, 5/8 in. and under. On other sections, from one to two parts clean sharp sand were used with the other proportions the same. While, on a part of the work, the aggregates were hauled separately to the mixer, some of them being obtained close at hand, it was found more convenient in constructing the remainder of the road to proportion the aggregates at a central material yard, from which they were hauled to the work by an industrial railway. Four cars made up a train which was hauled by a 20-hp. gasoline locomotive. A car carried three hoppers, each containing one complete batch for the mixer. The cars were run alongside the mixer, the hopper picked up by an automatic traveling crane on the mixer, and dumped into the charging hopper.

Screen tests were made of all the aggregates, and the mixtures used were designed to give the maximum density. On most of the work, hydrated lime was added to each batch in quantities varying from 5 to 10% by weight of the cement. The value of the lime lies, to a small extent, in the fineness of the particles serving as a filler, but chiefly in its lubricating properties. It is noticeable that concrete containing hydrated lime slips and flows into place more easily and forms a dense mix with much less tamping than that which does not contain lime. When lime is added, a less amount of water gives a greater plasticity, and there is therefore less danger of separation of the aggregates. Moreover, it is believed that the lime tends to hold moisture until the setting has passed the stage where loss of water due to absorption from the ground can affect it.

The presence of much moisture in the sub-base proved to be essential. Even though the sub-base was thoroughly soaked in every case before placing the concrete, it was observed that there were more natural contraction cracks where the soils were porous than where they retained moisture.

An Austin cube 1/3-cu. yd. mixer was used on most of the work. Each batch was mixed one minute, or 16 complete revolutions of the drum, and then depos-



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ited in a turnover bucket which ran out on a 20-ft. boom and dumped in place on the roadbed. The batches were given a rather dry mix, and when deposited, spread with hoes having blades 14 in. long and 2½ in. deep. When the base had been deposited for a distance of 20 ft., the Bowlby roller made one trip over it, forward and back. The skip was then loaded with the top mixture, made slightly more wet than the base, but not wet enough to bring water to the surface when floated lightly with a wooden float. The top layer, 1½ in. thick, was deposited on the base concrete and rolled at once. The time of exposure of the base concrete before the wearing surface covered it never exceeded ten minutes.

The roller used was designed by H. L. Bowlby for the purpose of combining a strike-off board and a uniform tamper. On its forward trip the roller carried a light wave of concrete in front of the roll, and since the roller covered the full width of the pavement and weighed approximately one and a half tons, it gave a heavy compression to the soft concrete, which proved to be much more uniform and effective than the ordinary tamping methods for removing voids and making a dense concrete. The crown of the pavement is provided for in the roller.

All pavement was covered with canvas and kept wet until it became sufficiently set to allow earth or sand to be spread upon it without sticking. This interval varied with the temperature and the wind. Care was taken to prevent the pavement from drying on the surface for even a short time. It was kept wet for eight days, and the earth cover left on for about thirty days, when the road was thrown open to traffic.

Daily records were kept of the work, of which the following is a specimen page:

SECTION 'C.' MIXER No. 1.

July 14, 1914.

Mixtures used—Surface, 1:1:2; base, 1:2:2:4.

Cement used—660 sacks.

Hydrates used—43 sacks.

Feet laid—345: station 568 plus 23 to 564 plus 78.

Total feet laid to date—1128 on Section 'C.' Cover good; with sand.

Temperature—8 a.m., 66, minimum; 12 m., 84; 5 p.m., 90, maximum.

Whenever a change in the mixture or in the use of hydrated lime was made, the fact was recorded, and bench marks and wires in the pavement were set so that exact records might be kept of the comparative wear of the different types of pavement.

The economical capacity of the mixer used on most of the work was 400 lineal feet of 16-ft. pavement, 6 in. thick, or 710 sq. yd. per eight-hour day.

Following is a summary of costs:

Item.	Amount.	Cost per sq. yd.	Per cent total.
Granite (including freight and hauling), 8010.2 cu. yd.	$ 30,745.05	$0.350	23.4
Cement (24,856.5 bbl.) and hydrate (210 tons), including freight and hauling	59,895.18	0.690	45.5
Sand and gravel (10,646 cu. yd.)	14,648.06	0.166	11.1
Paving (labor and superintendence)	16,313.64	0.185	12.4
Warehouse and spur track	695.77	0.008	0.6
Depreciation, repairs, and renewals	6,234.03	0.071	4.7
Storage	144.44	0.002	0.1
Telegraph and telephone	70.84	0.001	0.1
Total	$128,747.01	$1.473	97.9
Construction overhead	2,752.38	0.031	2.1
Grand total	$131,499.39	$1.504	100.0

This amount, $131,499.39, or $13,842 per mile, is 80.7% of the total cost of constructing the road. The average thickness of the pavement was 5.68 in. Asphaltic concrete 5 in. thick on an adjacent stretch of road cost $12,279 per mile. On a basis of equal thickness, the asphaltic concrete pavement would have cost $13,950 per mile, or slightly more than the cement concrete.

On most of the work, expansion joints of heavy asphalted felt were used, but on other sections of the road these were omitted.

An examination of a stretch of four-inch pavement, four months after the road was completed, disclosed the following conditions. On one section of 7100 ft., expansion joints were placed at approximately 30-ft. intervals, with a total of 235 joints. Between these joints, there have appeared 34 transverse cracks extending the entire width of the pavement, making the average distance at which this section had cracked, 26.3 ft. On another section of 8143 ft., expansion joints were placed only at the end of a day's run, 52 in all. In addition, 298 cracks developed, making the total number of cracks and joints 350, and the average distance of cracking 23.2 ft. In the portion of this latter section where 10 to 11% of hydrated lime was used, the average distance of cracking was 24.4 ft. Where hydrated lime was not used, the average distance of cracking was 21.3 feet.

Similar observations on a six-inch pavement showed the following. On a stretch of 10,029.7 ft., where 332 regular expansion joints were used, only three transverse cracks had developed, giving an average cracking distance of 30.2 ft. On a stretch of 5071.1 ft. where no contraction joints were used, the average cracking distance was 50.2 ft. On a portion of this latter section where 4 to 5% of hydrated lime was used, the average cracking distance was increased to 59.3 feet.

On the Columbia highway, in Clatsop county, about three miles of concrete pavement was laid. The pavement was eight feet wide and six inches thick. It was laid on an old macadam road, which was scarified, hand picked, and rolled, but an endeavor was made not to disturb the existing foundation, as this section of road was built up through a reclaimed swamp. About two thousand feet was laid as a single course pavement with a mixture of 1 cement to 1¾ screenings

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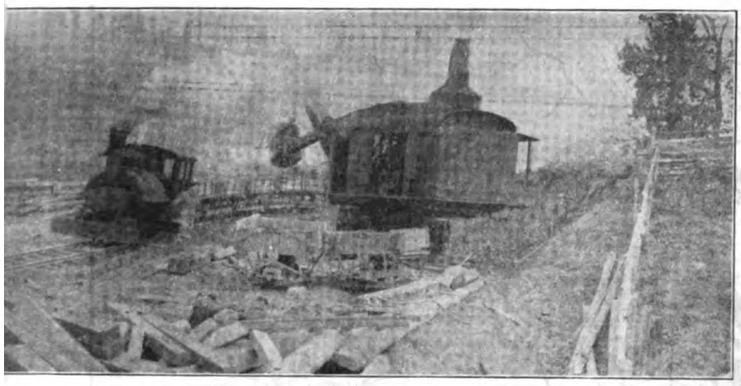
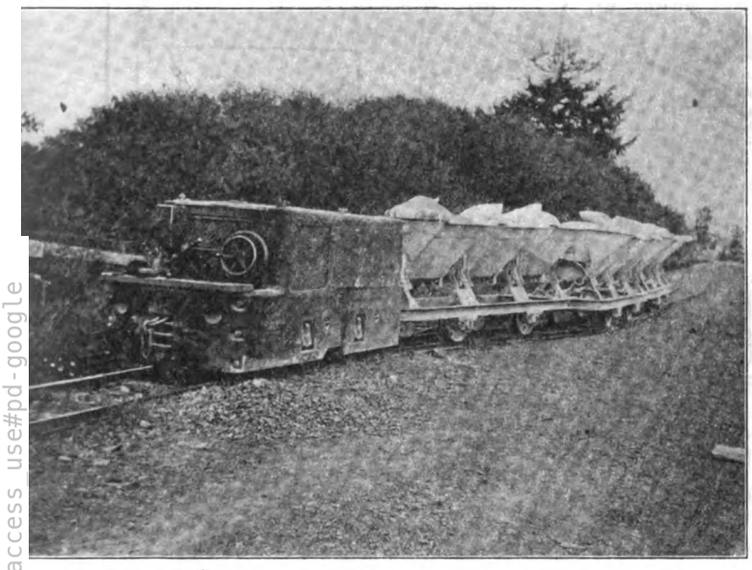
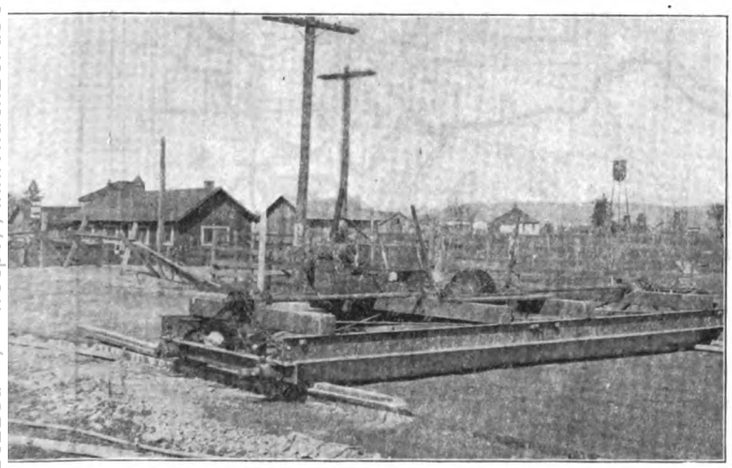
to 2¼ rock. On the remainder of the work two courses were laid, the bottom course, 4 in. thick, being composed of 1 cement to 2¼ screenings to 3 rock, and the



STEAM-SHOVEL LOADING CARS.



MATERIALS TRANSPORTED IN BATCH LOTS.



BOWLBY CONCRETE ROLLER.

top course, 2 in. thick, of 1 cement to 3 screenings. To the cement was added 10% of hydrated lime.

A central material yard was established on the river and near the centre of the work. Bunkers for the aggregate and a shed for cement were erected. Materials were delivered by scows, a donkey engine and derrick with a clam-shell bucket being used for unloading. The materials were proportioned at the yard and hauled to the work on an industrial railway, the equipment being similar to that used on the Jackson County road. Water was pumped from the river and distributed by a 2-in. pipe laid along the road, the pumping plant being moved three times as the work progressed. As with the Jackson County road, the Bowlby roller was used to secure the greatest density.

Following is a summary of the organization:

Overhead—Construction engineer, junior engineer, timekeeper.

Commissary—Cook, second cook, flunkey.

Hoist—Donkey engineer, donkey fireman, man on barge.

Mixer—Engineer, two men on bail, two men on hopper, one on bucket.

Pump—Tender.

Concrete roller—Driver.

Locomotive—Driver.

Miscellaneous laborers.

The cost data are summarized as follows:

Preliminary		
Grading:		
Labor	$ 469.01	
Miscellaneous	162.20	
		$ 631.21
Culverts:		
Labor	$1030.70	
Materials	526.96	
		1557.66
Turnouts and shoulders:		
Labor	$ 100.80	
Materials	38.86	
		139.68
Camp maintenance and deficit at boarding-house		597.47
Overhead, salaries and expenses		3222.34
Rental, etc., of hoisting equipment		774.14
Equipment		
Locomotive		$2762.36
Mixer		2326.85
Track (2 miles)		4604.80
Cars (12)		1884.97
Pump, engine, and pipe-line		1498.38
Concrete roller		592.54
Pipe-line (supply for camp and material yard)		268.66
Steam pump		97.11
Installation		
Material and storage yard:		
Labor	$ 745.51	
Materials	673.33	
		$1418.84
Camp:		
Labor	$ 167.36	
Materials	492.64	
		660.00
Track:		
Labor	$1752.08	
Materials (lumber for bridging)	88.89	
		1841.04
Water supply for concrete:		
Labor	$ 259.32	259.32

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OPERATION

Derrick and engine (material yard):		
Labor	$ 523.67	
Fuel, oil, and sundries	209.04	
		$ 732.71
Locomotive:		
Labor	$ 373.75	
Fuel, oil, and sundries	150.00	
		523.75
Pump:		
Labor	$ 231.02	
Fuel, oil, and sundries	83.52	
		314.54
Concrete roller:		
Labor	$ 80.05	
Fuel	8.10	
		88.15
Road roller:		
Labor	$ 129.00	
Fuel	15.70	
		144.70
Mixer:		
Labor	$1325.71	
Fuel, oil, and sundries	124.63	
		1450.34
Loading cars		732.61
Forms:		
Labor	$ 649.79	
Materials	143.60	
		793.39
Reinforcement		53.17
Expansion joints		209.94
Miscellaneous equipment:		
Tools	$ 195.45	
Cooking utensils	41.05	
Hardware	85.97	
Miscellaneous	163.62	
Canvas for concrete protection	127.50	
		613.59

TRANSPORTATION

Weight		4337 tons
Loading cars:		
Total cost		$ 732.71
Per ton		0.169
Placing track:		
Total cost		1841.04
Per ton		0.425
Actual hauling:		
Total cost		545.48
Per ton		0.126
Total cost per ton		0.72
Average length of haul		5380 feet
Cost per ton-mile:		
Loading and hauling	$0.290	
Preparing grade for track, laying, and upkeep	0.416	
		$0.706

The excessive cost for track was due to the extreme narrowness of the road to be paved. It was impossible to haul materials onto the road and use an ordinary mixer with loading skip. Probably these conditions would have resulted in a high cost per ton-mile for any system of hauling. It should also be noted that the average haul was short, which also militated against a low cost per ton-mile.

MATERIALS—UNIT COSTS

Total materials used: 4680 bbl. cement; 2450 cu. yd. screenings; 93.5 tons hydrated lime.

Cement:		
F.o.b. price per barrel	$ 1.750	
Loss on sacks	0.020	
Labor unloading and storing	0.027	
Fixed operating charges on derrick	0.043	
Cement shed	0.136	
		$ 1.976
Rock and screenings:		
F.o.b. price per cubic yard	$ 0.950	
Demurrage	0.360	
Fixed and operating charges on derrick	0.421	
Derrick platform	0.289	
		$ 2.020
Lime:		
F.o.b. dock, Astoria, per ton	$12.700	
Loss on sacks	0.020	
Dockage	0.250	
Loading on barge	0.250	
Freight to material yard	0.500	
Labor unloading and storing	0.158	
Fixed and operating charges on derrick	0.234	
Cement shed	0.758	
		$14.870

PAVEMENT—UNIT COSTS

Pavement laid: 16,560 lin. ft.; 14,720 sq. yd.; 2300 cu. yd. in place.

Item.	Total cost.	Cost per lin. ft.
Cement	$9247.68	$0.559
Lime	1390.34	0.083
Rock and screenings	4949.00	0.299
Reinforcing	53.17	0.004
Expansion joints	209.94	0.013
Placing tracks	1841.04	0.112
Loading cars	732.61	0.044
Locomotive	545.48	0.033
Mixer	1472.46	0.089
Water supply	573.86	0.035
Forms	793.39	0.048
Spreading	514.83	0.031
Finishing	225.94	0.013
Concrete roller	88.15	0.005
Sprinkling and covering	52.18	0.003
Overhead	3222.34	0.194
Total		$1.565

Or $1.76 per square yard.

Except for a distance of about 1600 ft. where no expansion joints were used, joints were placed every 30 ft. for the entire pavement. An examination of the road made three months after it had been put in service failed to disclose cracks in any part of the pavement. As the weather had been rainy during almost the entire period, this should not necessarily be taken as an indication that some cracks might not develop later.

The oxyacetylene method was recently applied in an interesting manner to some large water pipes. It was desired to change the direction of the piping, and this necessitated taking out some of the lengths of pipe. The usual method of either melting or chipping out the lead joints would have taken several hours. The oxyacetylene cutting torch was brought into action, and in a few minutes the joints were melted out and the pipe removed. This could have been performed with a welding torch.—*Mechanical World.*

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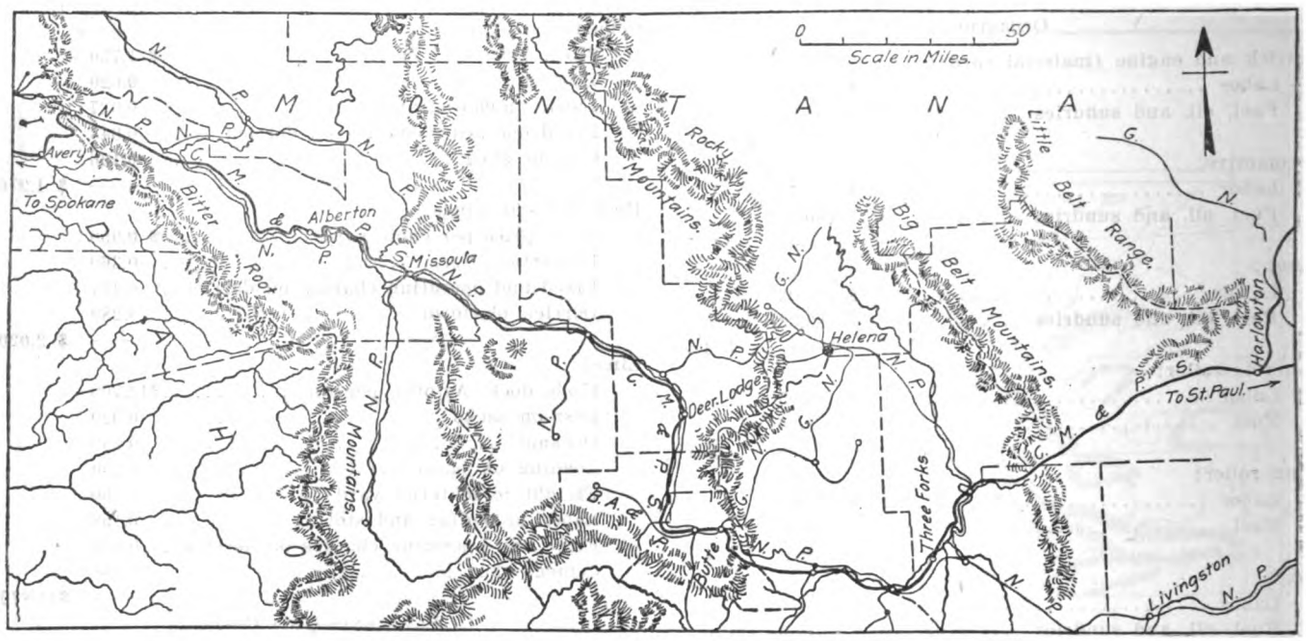

Electrification of the Chicago, Milwaukee & St. Paul Railway*

Plans for the electrification of the first engine division of the Chicago, Milwaukee & St. Paul railway have now been completed and contracts let to the General Electric Co. for the electric locomotives, sub-station apparatus, and line material, and to the Montana Power Co. for the construction of the transmission and trolley lines. This initial contract for 113 miles of main line between Three Forks and Deer Lodge is the first step toward the electrification of four engine divisions extending from Harlowton, Montana, to Avery, Idaho, a total distance of approximately 440 miles, aggregating about 650 miles of track, including yards and sidings. While this comprises the extent of track to be equipped in the near future, it is understood that plans are being made for electrification of the whole line from Harlowton to the coast, a distance of 850 miles, should the operating results of the initial installation prove as satisfactory as anticipated.

The plans of the Chicago, Milwaukee & St. Paul railway are of special interest, as this is the first attempt to install and operate electric locomotives on tracks extending over several engine divisions. The various terminal and tunnel installations on other roads have usually been called for because of local conditions; but the electrification of this road is undertaken purely on economic grounds with the expectation that superior operating results with electric locomotives will effect a sufficient reduction from the present cost of steam operation to yield an adequate return on the large investment required. The results of electric operation on such a large scale will go a long way toward the solution of the engineering and economic problems that must be considered in determining the advisability of making such an installation.

The first step taken toward electrification by the Chicago, Milwaukee & St. Paul railway was to enter into a contract with the Montana Power Company for an adequate supply of power over the 440 miles of main line considered for immediate electrification. The precautions taken both by the railway company and power company to safeguard the continuity of power supply should guarantee a reliable source of power subject to few interruptions of a momentary nature only.

The Montana Power Company covers a great part of Montana and part of Idaho with its network of transmission lines, which are fed from a number of sources, the principal ones being as follows:

	Kilowatts.
Madison river	11,000
Canyon ferry	7,500
Hauser lake	14,000
Big Hole	3,000
Butte, steam turbine	5,000
Rainbow falls	21,000
Small powers, aggregating	7,390
Total power developed	68,890

Further developments, part of which are under construction, are as follows:

	Kilowatts.
Great Falls	85,000
Holter	30,000
Thompson falls	30,000
Snake river	20,000
Missoula river	10,000
Total	175,000
Total power capacity developed and undeveloped	244,000

The several power sites are interconnected by trans-

*From data furnished by the General Electric Co., Schenectady, New York.

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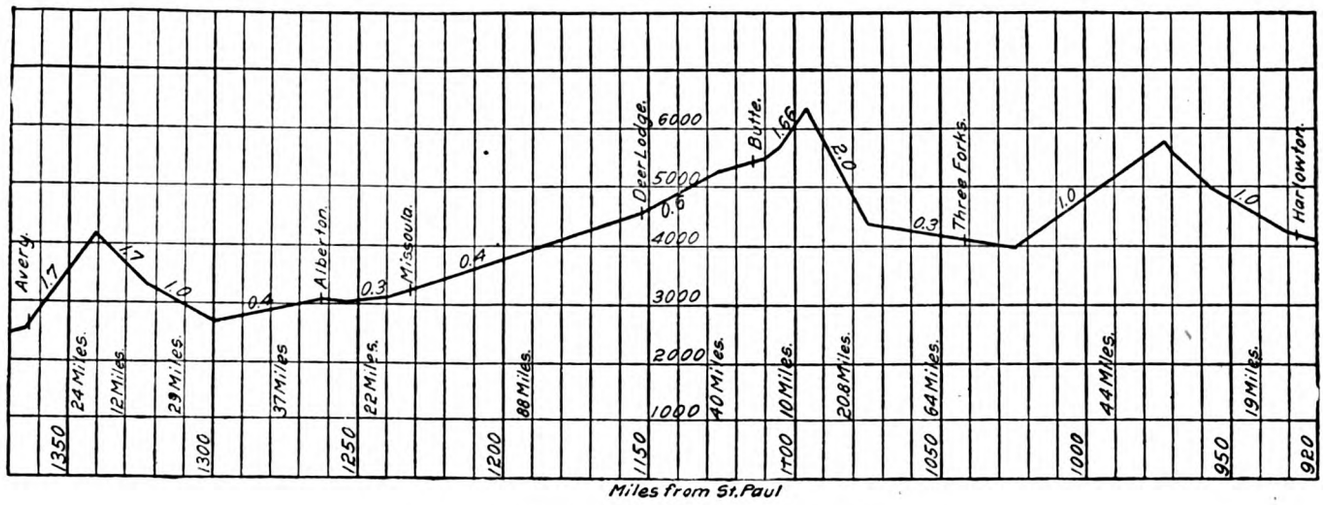

PROFILE OF PRESENT AND PROPOSED ELECTRIFIED DIVISIONS.

mission lines, supported on wooden poles and operating at 50,000 for the earlier installations, and on steel towers and operating at 100,000 volts for later installations. Storage is provided in the Hebgen reservoir of 300,000 acre-feet, supplemented by auxiliary reservoirs at the several power sites, making a total of 418,000 acre-feet in all. The Hebgen reservoir is so placed at the head waters of Madison river that water drawn from it can supply in turn the several installations on the Madison and Missouri rivers, so that the same water is used a number of times, affording an available storage considerably greater than is indicated by the figures given.

Due to the great facilities available and the low cost

TRAIN ASCENDING 2% GRADE.

of construction under the favorable conditions existing, the railway company will purchase power at a contract rate of $0.00536 per kw.hr. based on a 60% load factor. It is expected under these conditions that the cost of power for locomotives will be considerably less than is now expended for coal. The contract between the railway and power companies provides that the entire distance between Harlowton and Avery, comprising four engine divisions, will be electrified by January 1, 1918.

In order to connect the sub-stations with the several feeding-in points of the Montana power transmission lines, a tie-in transmission line is being built by the railway company that will permit feeding each sub-station from two directions and from two or more sources of power. This transmission line will be constructed with wooden poles, suspension type insulators, will operate at 100,000 volts, and will follow, in general, the right-of-way of the railway company except where advantage can be taken of a shorter route over public domain to avoid the necessarily circuitous line of the railway in the mountain districts.

The immediate electrification of 113 miles will include four sub-stations containing step-down transformers and motor-generator sets with necessary controlling switchboard apparatus to convert 100,000 volt, 60-cycle, three-phase power to 3000 volts direct current. This is the first direct current installation using such a high potential as 3000 volts, and this system was adopted in preference to all others after a careful investigation extending over two years. The 2400-volt direct current installation of the Butte, Anaconda & Pacific railway in the same region furnished a good opportunity for the study of high-voltage direct-current locomotive operation, and the selection of 3000 volts direct current for the Chicago, Milwaukee & St. Paul was due in a large measure to the satisfactory performance of the Butte, Anaconda & Pacific installation.

On the latter road, a comparison based on six months' steam and electric operation shows a total net saving of more than 20% on the total cost of electrification, not counting increased capacity of the lines, improvement of the service, and more regular working hours for the crews. The comparison also shows that the tonnage per train has been increased by 35%, while the number of trains has been decreased by 25%, with a saving of 27% in the time required per trip.

Sub-Stations

The sub-station sites of the Chicago, Milwaukee & St. Paul electrified zone provides for an average intervening distance of approximately 35 miles, notwithstanding that the first installation embraces 20.8 miles

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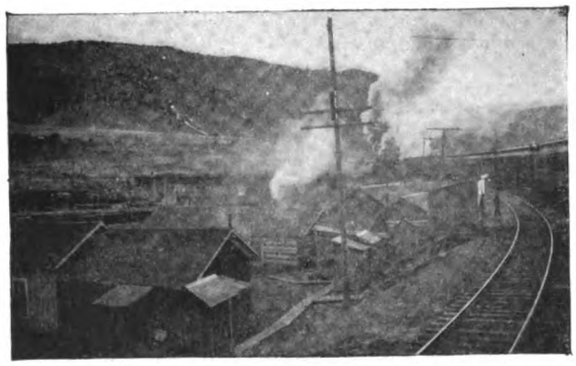
of 2% grade west bound and 10.4 miles of 1.66% grade east bound over the main range of the Rocky Mountains. With this extreme distance between sub-stations and considering the heavy traffic and small amount of feeder copper to be installed, the importance of such a high potential as 3000 volts direct current, permitting as it does a minimum investment in sub-station apparatus and considerable latitude as to location sites, is apparent.

The sub-stations will be of the indoor type, transformers being three-phase, oil-cooled, and reducing from 100,000 volts primary to 2300 volts secondary, at which potential the synchronous motors will operate. The transformers will be rated 1900 and 2500 kva.



CROSSING OF MISSOURI RIVER AT LOMBARD, MONTANA.

and will be provided with four 2½% taps in the primary and 50% starting taps in the secondary.

The motor-generator sets will comprise a 60-cycle synchronous motor driving two 1500-volt direct-current generators connected permanently in series for 3000 volts. The fields of both the synchronous motor and direct-current generators will be separately excited by small generators direct connected to each end of the motor-generator shaft. The direct-current generators will be compound wound, will maintain constant potential up to 150% load, and will have a capacity for momentary overloads up to three times their normal rating. To insure good commutation on these overloads, the generators are equipped with commutating poles and compensating pole-face windings. The synchronous motors will also be utilized as synchronous condensers, and it is expected that the transmission line voltage can be so regulated thereby as to eliminate any effect of the fluctuating railway load.

The location and equipment of the several sub-stations is as follows:

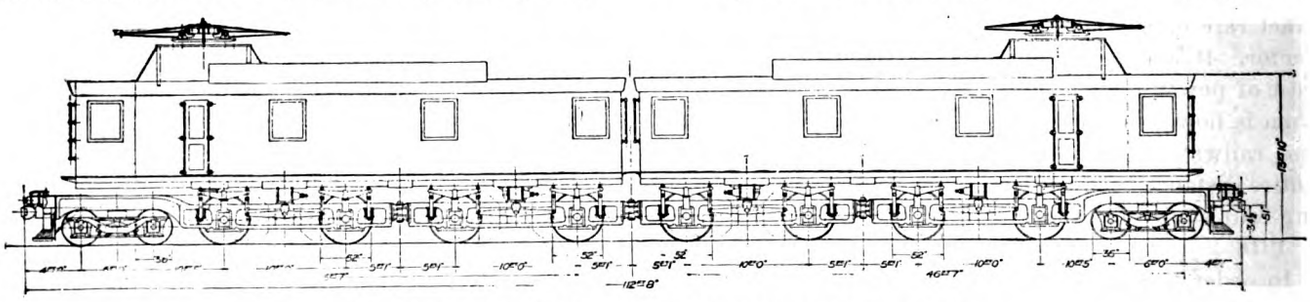
Station.	Miles from Deer Lodge.	No. of units.	Kilowatts per unit.	Total.
Morel	17.1	2	2000	4000
Janey	50.5	3	1500	4500
Piedmont	77.9	3	1500	4500
Eustis	120.6	2	2000	4000

Overhead Construction

The trolley construction will be of the catenary type, in which a 4/0 trolley wire is flexibly suspended from a steel catenary supported on wooden poles, bracket construction being used wherever track alignment will permit, and cross-span construction on the sharper curves and in yards. Steel supports instead of wooden poles will be used in yards where the number of tracks to be spanned exceeds the possibilities of wooden pole construction. Poles for the first installation are already on the ground and 30 miles of poles are set. This part of the work will be completed in the summer of 1915, ready for operation in the fall on the delivery of the first locomotives.

As the result of careful investigation and experiments, a novel construction of trolley will be installed, namely, the so-called 'twin-conductor' trolley. This comprises two 4/0 wires suspended side by side from the same catenary by independent hangers alternately connected to each trolley wire. This form of construction permits the collection of very heavy current by reason of the twin contact of the pantograph with the two trolley wires, and also insures sparkless collection under the extremes of either heavy current at low speed or more moderate current at very high speeds. It seems that the 'twin-conductor' type of construction is equally adapted to the heavy grades calling for the collection of very heavy currents, and on the more level portions of the profile where maximum speeds of 60 miles per hour will be reached with the trains having a total weight of over 1000 tons. The advantage of this type of construction is due partly to the greater surface for the collection of current, but mainly to the very great flexibility of the alternately suspended trolley wires, a form of construction which eliminates any tendency to flash at the hangers either at low or high speed.

Including sidings, passing, and yard tracks, the 113 miles of route distance is increased to approximately 168 miles of single track to be equipped be-



OUTLINE OF 3000-VOLT DIRECT-CURRENT ELECTRIC LOCOMOTIVE.

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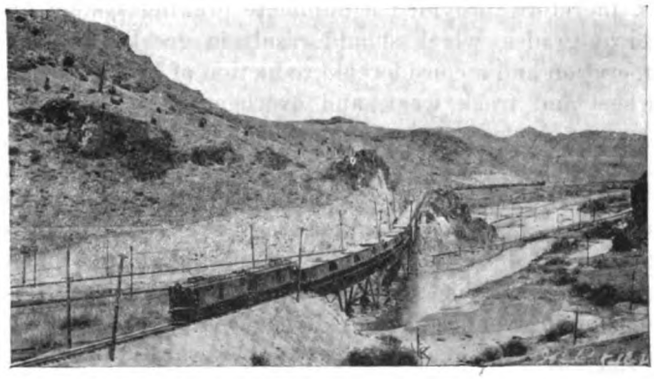
tween Deer Lodge and Three Forks in the initial installation.

Locomotives

The locomotives are the first to be constructed for railroad service with direct-current motors designed for as high a potential as 3000 volts. They will weigh approximately 260 tons and will have a continuous capacity greater than any steam or electric locomotive yet constructed. Perhaps the most interesting part of the equipment is the control, which is arranged to effect regenerative electric braking on down grades. This feature as yet has never been accomplished with direct-current motors on so large a scale. The general characteristics as proposed are tabulated below:



ORE TRAIN ON BUTTE, ANACONDA & PACIFIC.

Total weight, tons	260
Weight on drivers, tons	200
Weight on each guiding truck, tons	30
Number of driving axles	8
Number of motors	8
Number of guiding trucks	2
Number of axles per guiding truck	2
Total length of locomotive, feet	112
Rigid wheel base, feet	10
Voltage of locomotive	3000
Voltage per motor	1500
Horse-power rating, 1 hour, each motor	430
Horse-power rating, continuous, each motor	375
Horse-power rating, 1 hour, complete locomotive	3440
Horse-power rating, continuous, complete locomotive	3000
Trailing load capacity, 2% grade	1250
Trailing load capacity, 1% grade	2500
Approx. speed at these loads and grades, miles per hour	16

The Chicago, Milwaukee & St. Paul railway, from Harlowton to the coast, crosses four mountain ranges: the Belt mountains at an elevation of 5768 ft., the Rocky mountains at an elevation of 6350 ft., the Bitter Root mountains at an elevation of 4200 ft., and the Cascade mountains at an elevation of 3010 feet. The first part of the electrification between Three Forks and Deer Lodge calls for locomotive operation over 20.8 miles of 2% grade between Piedmont and Donald at the crest of the main Rocky Mountain divide, so that the locomotives will be fully tested as to capacity and general service performance.

The initial contract calls for nine freight and three passenger locomotives having the above characteristics and similar in all respects, except that the passenger locomotives will be provided with a gear ratio permitting the operation of 800-ton trailing passenger trains at about 60 miles per hour, and will, furthermore be equipped with an oil-fired steam-heating outfit for the trailing cars. The interchangeability of all electrical and mechanical parts of the freight and passenger electric locomotives is of great importance from the standpoint of operation and maintenance.

The cab consists of two similar sections extending practically the full length of the locomotive. Each section is approximately 52 ft. long and the cab roof is about 14 ft. above the rail exclusive of the housings for ventilation. The trolley bases are about 5 ft. above the roof, owing to the unusual height of the trolley wire, which will be situated at a maximum elevation of 25 ft. above the rail. The outer end of each cab will contain a compartment for the engineer, while the remainder is occupied by the electric control equipment, train heater, and air-brake apparatus.

AVERY, IDAHO, WESTERN END OF ELECTRIFICATION.

IN THE BITTER ROOT MOUNTAINS.

Motors

The eight motors for the complete locomotive will be type GE-253-A. This motor has a normal one-hour rating of 430 hp. with a continuous rating of 375 hp.

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The eight motors will thus give the locomotive a one-hour rating of 3440 hp., and a continuous rating of 3000 hp., making it the most powerful steam or electric locomotive ever built. The draw-bar pull available for starting trains will approximate 120,000 lb. at 30% coefficient of adhesion.

Each motor will be twin-geared to its driving axle in the same manner as on the Butte, Anaconda & Pacific, the Detroit River Tunnel, and the Baltimore & Ohio locomotives, a pinion being mounted on each end of the armature shaft. The motor is of the commutating pole type and has openings for forced ventilation from a motor-driven blower situated in the cab.

SITE OF POWER PLANT.

The freight locomotives are designed to haul a 2500-ton trailing load on all gradients up to 1% at a speed of approximately 16 miles per hour, and this train-load unbroken will be carried over the 1.66 and 2% ruling grades on the west and east slopes of the Rocky Mountain divide with the help of a second similar freight locomotive acting as pusher. Track provision is being made at Donald, the summit of the grade, to enable the pusher locomotive to run around the train and be coupled to the head end to permit electric braking on the down grade. In this case, the entire train will be under compression and held back by the two locomotives at this head end, the entire electric braking being under the control of the motorman in the operating cab of the leading locomotive. It is considered that electric braking will prove valuable in this mountain railroading; for, in addition to providing the greatest safety in operation, it also returns a considerable amount of energy to the sub-stations and transmission system, which can be utilized by other trains demanding power. In this connection, the locomotives will have braking capacity sufficient to hold back the entire train on a down grade, leaving the air-brake equipment with which they are also equipped to be used only in emergency and when stopping the train. There is, therefore, provided a duplicate braking system on down grades, which should result in great safety of operation and a considerable reduction of break-downs, wheel and track wear, and overheating, with consequent reduction in maintenance and improvement in track conditions.

With the completion of the remaining engine divisions, it is proposed to take advantage of the possibilities afforded by the introduction of the electric locomotive to combine the present four steam-engine divisions into two locomotive divisions of approximately 220-mile lengths, changing crews, however, at the present division points. As the electric locomotive needs inspection only after a run of approximately 2000 miles, requires no stops for taking on coal or water, or lay-over due to dumping ashes, cleaning boilers, or petty roundhouse repairs, it may be reasonably expected that the greater flexibility of the locomotive so provided will result in considerable change in the method of handling trains now limited by the restrictions of the steam-engine.

The electrification of the Chicago, Milwaukee & St. Paul is under the direction of C. A. Goodnow, assistant to the president in charge of construction, and the field work is under the charge of R. Beouwkes, electrical engineer for the railway company.

Road Surfaces for Light-Volume Mixed Traffic*

By PERCY S. HOOKER†

In a subject of this kind the first question to determine is the exact meaning of the title. What is light-volume mixed traffic? How many vehicles are to pass over a given piece of highway and still be classed as light volume? What is their relative proportion as to motor propelled and horse drawn? I confess I am not clear upon the right interpretation of these terms. There are sections of the country where presumably the mixed traffic would consist almost entirely of horse-drawn vehicles, while in others a very large percentage would be motor traffic. The treatment of the surface of these two subdivisions would vary to a considerable extent. I am inclined to consider the subject as being the treatment of subsidiary roads which have only the horse-drawn traffic originating upon the road, together with motor traffic of the pleasure class and little or no freight traffic which is motor driven.

From my point of view, the word 'surfaces' is somewhat superfluous, and the subject is the entire treatment, comprising the subgrade and drainage conditions, which must be considered as part of the surfacing in order to treat intelligently its surface. I shall treat the subject, therefore, broadly as the im-

*Read at Fourth American Road Congress, Atlanta, Georgia, November 9 to 14, 1914.

†State Superintendent of Highways of New Hampshire.

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provement of the ordinary country road as it now exists, the purpose being to obtain the greatest amount of linear feet with the least expenditure of money.

With the immense mileage of roads in the United States, it seems to me perfectly clear that even in the wealthier states a large proportion of the roads will never be improved under the types of construction which are now considered necessary for their improvement and that 90% of the entire mileage will be unimproved if it is necessary to improve them with the higher types of construction. My impression is that there must be a revulsion of feeling which will compel more mileage and less cost. Given, then, a country highway as it now exists, and the proposition that for 10 miles of this road there is only available the sum of $25,000, what can we do to render this really an improved road, which under proper maintenance will take care of the traffic upon it? A preliminary survey may show that a portion of the road is in a low-lying level section without proper ditches, where at present the natural tendency of the road is to act as a sort of drainage canal for lands adjacent to it, the soil itself consisting partly of leaf mold containing a large amount of humus, and which, if used as a cultivated field, would produce good crops. The next portion may consist of a sand and gravel formation, containing boulders and on a grade of from 5 to 8%, rolling over elevations and down into hollows and gullies and eventually working out into clear deep sand. Succeeding this may be a hollow from which you rise upon a side-hill cut through a clay bank. Here arises the proposition that the clay is of such a nature as to practically absorb all the water and the drainage condition is most difficult to handle. The last section may be through a ledge of native rock or large boulders, the soil slightly covered with either hardpan or sand, and upon grades which easily wash under the annual rainfalls. On almost all country roads several of these conditions will ordinarily appear, while, of course, it is an exaggeration to say that they will all occur within the 10-mile stretch.

Confronted with these conditions, it seems to me to be absurd to attempt a standardization of such a highway in order economically to work out the problem. Use must be made of material which is comparatively local, and the treatment of each section will be different.

The width of the present highway must first be taken up and in general standardized for the ordinary traffic. Probably a width of 21 ft. between ditches is the most satisfactory standard, and considering that this should be accepted as the width of the road, you are next confronted with the alignment and drainage.

In all probability the alignment will be comparatively easy over the level fertile section, but the drainage on this section will be the principal problem. Here in general you must first provide by deep ditching for reducing the water-level of the surrounding land; and by deep ditching I do not mean the ordinary ditch from which the crown of the road rises, but in many instances a ditch which acts to a considerable extent as a drainage canal. Culverts must be provided at all points where the drainage may be taken away from the road at every accessible point, and however level you may consider the plain or plateau as a whole, you will doubtless find a large number of places by which the water will be conveyed entirely away from the road and bother you no more.

In most instances the grading material obtained from the ditches, though seemingly of very inferior quality, may be used to raise the general grade of the road, and if kept dry by the side ditches, will compact and make a fair subgrade.

The next essential is in some way to obtain upon such raised grade a sufficient quantity of metal of some kind to prevent the cutting through of the road surface from water which falls upon the road, or in flood seasons cannot be entirely carried away by the ditches. In my plan this may be obtained from either fields, stone fences, or even drawn from section two, which has an entirely different soil. In some places it would be necessary practically to lay this stone as telford. In other places it is enough simply to dump it in the road and only partly place it by hand labor. In many places where a roller is available this may be the method and the stone simply forced into the soft material excavated from the ditches and which has not as yet thoroughly dried out from the service rendered by the ditches.

Now what shall be applied as the surface material? In many places you will find that along or adjacent to the road there are hills or hummocks which contain soil not properly either hardpan or clay, but in many places a combination of each, containing considerable metal in the shape of either pebbles or fractured stone. Having obtained the bottom through drainage and the addition of stone so that you are confident the sub-base will be practically dry, you may apply 10 in. of the material containing a small amount of metal, and by the use of road drags and road hones bring this first into section and next into a smooth hard surfacing which will prove satisfactory in all weather for traffic, provided it has constant attendance and is repeatedly, after every rain, dragged with the ordinary road drag. The drag removes every slight rut which may be started and does not allow the water to settle through the weak upper surfacing. The maintenance must not be intermittent, but constant. You may find that you still have a somewhat slippery upper surface, in which case it will be necessary to add an inch or two of the gravel or sand from section two. You will find that this will only require from 3 to 6 yd. of the gravel surfacing per 100 ft., and while it may be at a considerable distance from the improvement, it will not add materially to the cost.

The surfacing upon such a type of road will require practically 2000 yd. per mile, and if the material is

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from different banks along the roads, the cost will not exceed 20c. per yard. It is, then, perfectly feasible over this section to build such a highway, including the raising of the grade from one to two feet, at a cost of not more than the estimated limit of $2500 per mile.

On section two, as I have imagined it, you have a problem of grading rather than of drainage. That is, the soil will readily dispose of the water, but you must reduce the grades to a reasonable gradient and with a sandy material provide some method for compacting the road. The first to consider, then, is what shall be the maximum grade.

I confess that in this class of construction I proceed backward, like a crab, rather than attempt to dictate an absolute gradient. That is, I take the heaviest grade and see to what per cent I can reduce this with a reasonable amount of money. Instead of saying arbitrarily that a 4% grade is the maximum, I figure how much it will cost for a 4%, how much less for a 5%, and what the saving would be should I allow it at even a 6% grade. We will say that I have found that I may reasonably reduce the grade on this section to 5%. This I establish as a maximum, and the other grades are brought to this maximum.

There will doubtless be considerable blasting to do on the large boulders on this section in order properly to widen the road, because the ordinary country road has no established width. In cutting the grades, you will usually find that a considerable portion of the material which you have excavated in reducing the grade makes good surface material, and almost the entire expense will be the shaping of the roadway and the drainage.

As I have imagined it, however, as you approach the end of this section you have run through the gravel and into what is practically sand. Here the gravel that you have on the other end will not properly compact or pack so as to make a suitable road surface, and you will have to build practically a sand-clay road. I have not had good success with the sand-clay roads, unless I have practically telfordized them by making the sub-base largely of metal.

In my treatment of this particular part of section two, I should endeavor to obtain, from the gravel pits used on the first part of it, small boulders sufficient to build the entire bottom of the road to at least 6 in. thick of such pebbles. These I should fill with sand up to the top of the metal, then put on at least three alternating sections of clay and sand, repeating until I had the road at least 10 in. thick, harrowing each section as it is built up, and seeing that the top surface is of sand rather than of clay.

This portion of the section, as I advise building it, will doubtless cost much more than the sum per mile that you have expended upon the gravel portion, but together they should leave your general average within the limit.

Section three, consisting largely of grade, is almost entirely a drainage proposition, and it will be necessary practically to tap the water coming from the side-hill near the surface or originating within the road. You may find it necessary in many instances to run short drains for the express purpose of tapping the water holes which come up in the roadbed proper, and it will doubtless be necessary, on the inside of such a road, to lay a side drain the entire length of every grade. A ditch should be dug on the upper side of the road to a depth of at least below frost line, a foot of sand being placed in the bottom and then an open drainage tile laid to as perfect a grade as possible, and the ditch filled in with sand. This seems to be the most satisfactory way of cutting off this water.

Having shaped the clay road, which is a comparatively easy matter, as such a road will retain its section, it may be practically worked with a road machine and then covered with not to exceed 2 in. of sand and gravel, harrowed in as thoroughly as possible, though it is somewhat difficult upon a clay road to get the sand to work into it at first. The further application during wet weather of at least 2 in. more will ordinarily give such a road a most desirable surface. The only caution is that you must not apply the sand in large quantities at a time, but must expect to renew this surface frequently during the first two years.

We have assumed that we have now come to the ledge and boulder section, and that all material must be drawn from a considerable distance to make a satisfactory road. Here, without question, the most feasible plan is to use a macadam roadway. The putting up of a local crusher and the macadam method of construction may enable you to build at a less cost than would the use of the uncrushed material. Frequently, however, on such sections there is great difficulty in getting sufficient water properly to flush a water-bound macadam road. You may obviate the use of large quantities of water by the use of bitumen, but this adds greatly to the cost of the road.

Wherever macadam is used, you may retain the same 21-ft. section, though 15 ft. should be the extreme width of the metalling. This will take 2600 tons of stone per mile, and, assuming the use of 2¼ gal. of bitumen per square yard, the added cost will be something over $2000 per mile. If water is fairly available, you may build your water-bound road and apply ½ gal. per square yard of bitumen as a cover coat at a cost of about $650 per mile, which will reduce the cost of your road for light traffic about $1500 per mile. Unless there is considerable trouble about getting your water, therefore, I should recommend the use of water-bound macadam with the blanket coat.

You must consider also the added cost of maintenance upon your macadam road as compared with the cheaper forms, so that personally I should hesitate about using macadam whenever there is a possibility of using the cheaper surfacing.

Assuming a small apportionment available for the

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entire mileage needing improvement, the economic question is what plan will you adopt for the treatment of such a highway. Will you practically complete this 10 miles with your money or will you build 3 miles of the higher type of roadway and leave the rest unimproved. This seems to be the attitude adopted by most highway departments. They standardize their plans and specifications, and are content with the small mileage of what they are willing to say is the best construction, and they dislike extremely to build for small cost what they term an inferior type of road.

I believe this is a serious economic error, and in most sections a road infinitely better than has previously existed may be built at a comparatively small cost, to the great betterment of the roads in general and to the great help of the inhabitants of a state.

As far as automobile traffic is concerned, I am sure that many of the inferior types of road are far more satisfactory to them in general than the highest type. Your autoist cares little for a short section of the best possible road if at the end of it he plunges into what he is pleased to call an impassable road for three-quarters of the distance. I believe the development of roads in the future will be along the line of more mileage and less cost and that this is the proper trend of development.

I have talked so far almost entirely about the preliminary building of such surfaces. I want to say a little about the cost and methods of maintenance on these types of road.

Constant continuous maintenance is necessary upon all the types of roads that are built. It is indispensable, however, that upon the surfaces of the cheaper type of roadway the maintenance be both continuous and intelligent.

A road of what may be called natural surfacing, if left for even a week during the summer season without attention, loses all its features of a good road. It must be constantly patroled, all holes in it which have worn must be filled, all weak spots which develop must be repaired within a few hours after discovery or your road will so rapidly degenerate that it is useless as an improved road.

The higher types of roadway may be left for varying periods of time without attention, and while this results in the end in being a more expensive method of treatment, you still have the road which may be repaired, but if you attempt this sort of treatment upon your cheap surface you eventually lose your highway entirely.

My experience is that a patrolman with a horse and cart, an efficient drag or hone, and the willingness to work will keep in almost perfect condition from 5 to 7 miles of a cheaply constructed roadway, at an approximate cost of from $175 to $200 per mile.

Given the same mileage of the higher types of road he will require a helper, a much larger equipment, and if working upon bituminous roads, not less than $150 per mile for material in the way of bitumen, crushed stone, etc.

My average cost of maintenance upon the higher types of road, including the use of a blanket treatment once in two years will not be less than $500 per mile, and in many instances it will greatly exceed this. On the expensive road also you are constantly facing the fact that within a reasonable number of years you must resurface at a cost approximating $6000 per mile, while upon your cheaper road, if properly patroled, you will find that your surface material is thicker than it was at the time the road was built and has been in practically perfect condition during the entire period.

If the dust nuisance upon your cheaper road becomes intolerable, it may be alleviated greatly and practically removed by the application of light bituminous oils or tars. The objection to this treatment, however, is the tendency on the part of a patrolman to allow the road to get out of section by neglecting to drag it after every rain, as he does not wish to destroy the skin coating on top, which is left after the treatment.

The cost of this treatment adds about $150 per mile to the cost of maintenance, and on the whole is not as satisfactory for light travel in its final results, as adhering to the use of the natural soil and the regular treatment by dragging.

Road problems may be roughly divided into four subdivisions, and their order of importance is about as follows: drainage, alignment, grade, and surfacing.

It is unfortunate that to most people the latter is more important, while relatively it is of far less importance than the other three. The surfacing material is frequently considered paramount, and the settling of the question as to whether you have a bituminous road, penetration method of mixing, a concrete road, or a pavement type is the main subject of discussion and has far more attention given to it, than in my opinion it rightly deserves.

Your drainage, alignment, and change of grade are permanent features. The surfacing can never be permanent. I have sometimes wondered whether a bond issue to be paid for by posterity should ever be expended on any feature that is not permanent.

Admittedly, surfacing of all kinds will require not only constant maintenance but rebuilding. With the essentials fully attended to it is surprising how the surfacing may be maintained at a comparatively small cost. I believe that it is as necessary for us to turn our attention to the economic side of the road question as to the scientific. A highway must have an economic road rental, as well as a fixed road maintenance, and wherever the actual cost plus its maintenance exceeds its rental value we are wasting money in building too expensive a road. We must so adjust the scales that our costs are such as to provide a roadway for the traffic at the least possible expense.

I realize that this is a very sketchy treatment of the subject given me. It is not scientific, but it equally is not theoretic. Financial problems in a state with a very small assessment roll and a large road mileage have made it a necessity in my state.

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Reinforced Concrete Screw-Conveyor and Elevator Construction

By D. C. FINDLAY*

In the construction of a new raw grinding cement mill for the Vancouver Portland Cement Co., Limited, of Victoria, B. C., concrete was used for the rather unusual purpose of building all the 16-in. screw-conveyor casings and also for the elevator legs.

Concrete Elevator Legs

Referring to Fig. 1, the details of construction are shown. Steel forms were built, designed to be easily

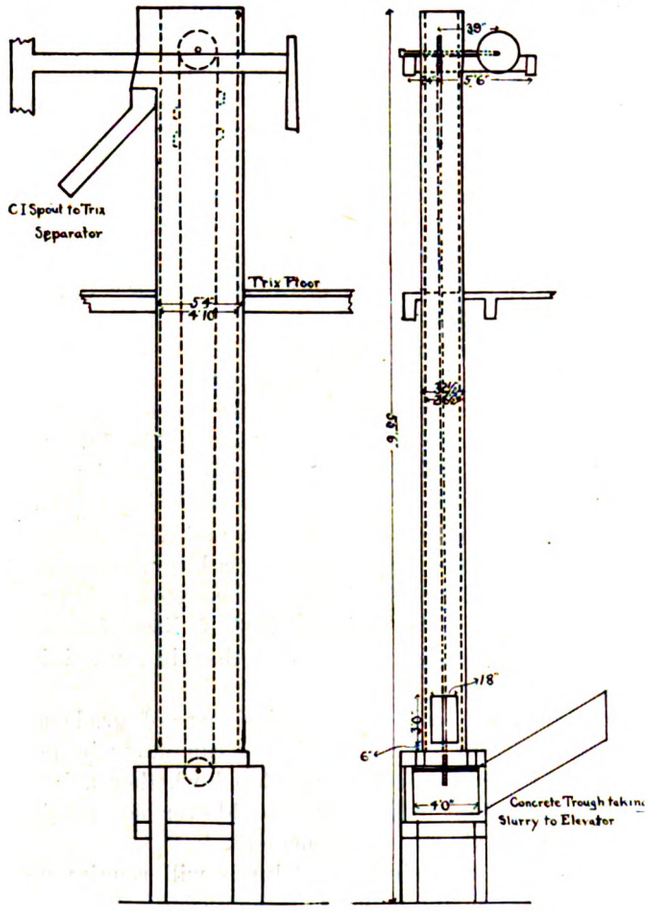

FIG. 1. CONCRETE ELEVATOR LEG.

collapsed, and were used for the inside and outside forms. The walls of the elevator were carried up 3 in. thick the entire height of 47 ft. 6 in. from the mill floor, and were reinforced by ½-in. round reinforcing bars running continuously through the entire height, and being held in position by a 1 by $\frac{1}{16}$-in. hoop steel spaced at 12-in. centres and securely wired to the vertical bars at every intersection. Two steel forms were used, and after pouring the first section the second form was bolted to the angle iron flanges, and poured, before stripping the former. This insured a smooth joint between each pouring of a 6-ft. section.

*Mount Tolmie road, Victoria, B. C.

These elevators raise the wet slurry as discharged from the Kominuter mills, and discharge it through cast iron spouts 10 in. diameter and flared to fit the rectangular discharge opening into the Trix separators on the separator floor.

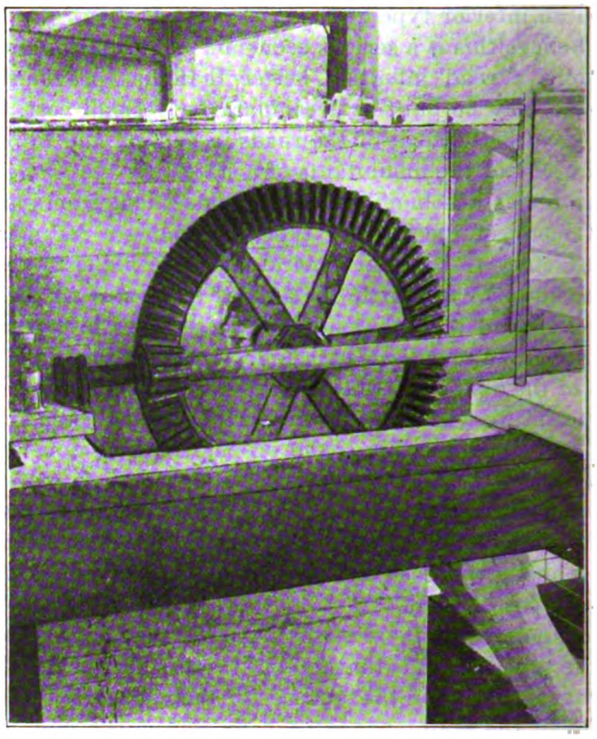

FIG. 2. HEAD OF ELEVATOR.

The plan view shows the method of leading the wet slurry, containing about 33% of water, into the boot of the elevator. The slurry is discharged into a con-

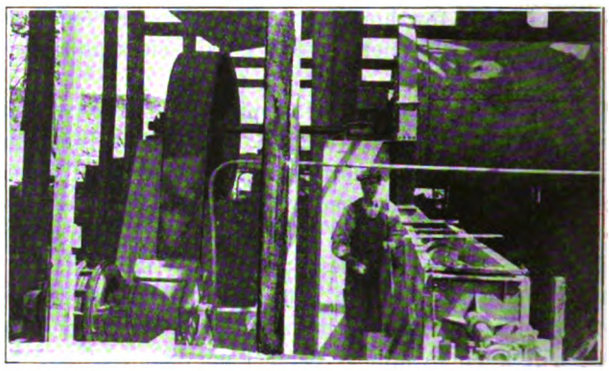

FIG. 8. SCREW AND HANGERS IN POSITION

crete box on an incline and carried by beams and columns. These beams and columns serve also to support the dead weight of the elevator casing, which weighed about 25,000 lb., as well as the slurry, which is con-

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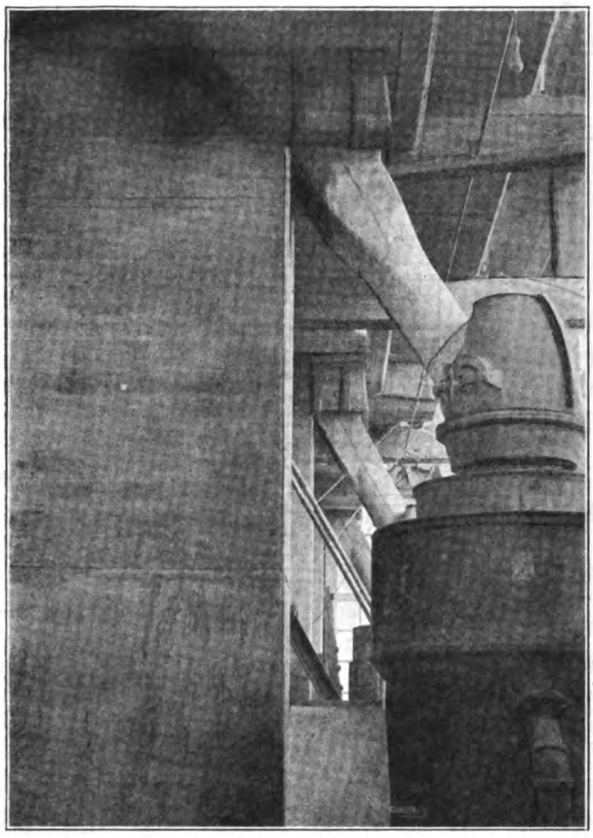

FIG. 3. HEADS OF ELEVATORS.

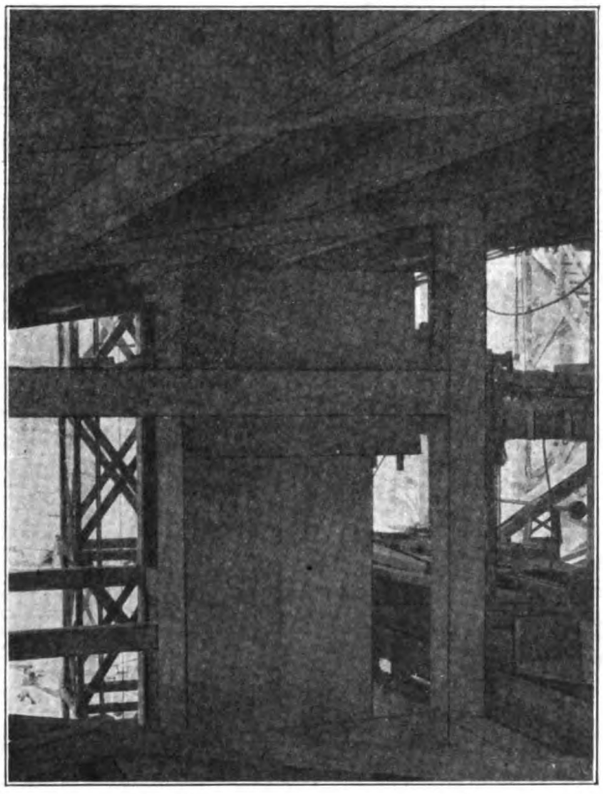

FIG. 4. ELEVATOR LEG IN POSITION.

tinually running down to the buckets, which are 7 by 7¼ by 16 in., carried by No. 844 elevator chain.

An opening was left in the bottom with a steel door for examination and fastening on buckets, and the top has a steel cover bolted to the concrete with hinged doors, which completely uncovers the traction wheel, enabling work to be done on the elevator buckets.

The entire weight of the loaded buckets, chain, etc., is carried by two 8 by 14-in. concrete beams running each side of the elevator leg, and having bolts set in the concrete to attach the bearings. The elevator is driven through a bevel gear directly off the mill pinion shaft.

Fig. 2 shows the head of an elevator with its bevel gear and the cast iron spout to the Trix separator. Fig. 3 shows the concrete construction around the heads of the elevators and a part of three of the elevator legs in operation. Fig. 4 is a view taken during construction of the mill, showing the elevator leg in position.

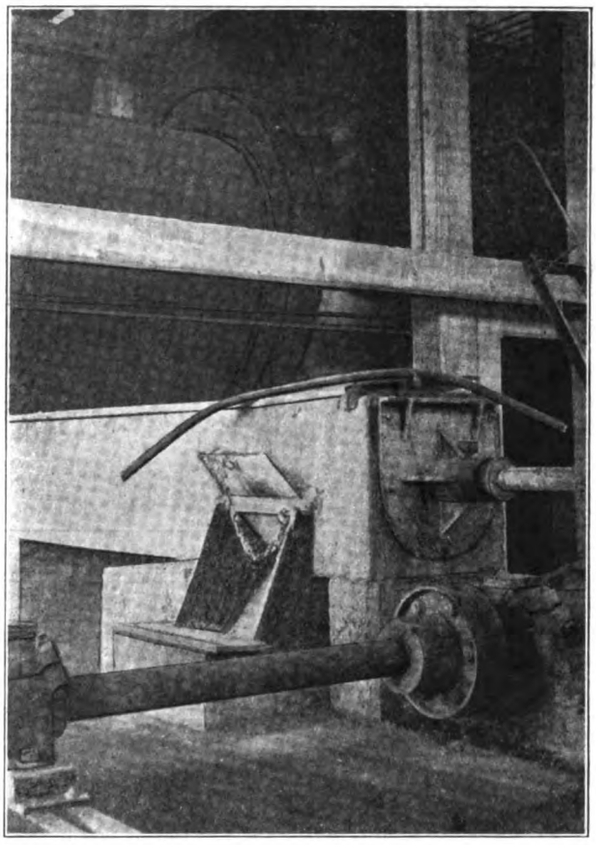

FIG. 7. DISCHARGE END OF SCREW CONVEYOR.

Four elevators have been built and in operation since August 1913, with very satisfactory results, and at the cost per elevator of approximately $200 exclusive of chain, buckets, etc., which was about half of the best quotation for a steel elevator leg.

Concrete Screw-Conveyors

In order that all details in the new mill should be of concrete, the 16-in. screw conveyors handling the wet slurry from the separators to the tube-mills, and from the tube-mills to the correcting basins, were designed in concrete.

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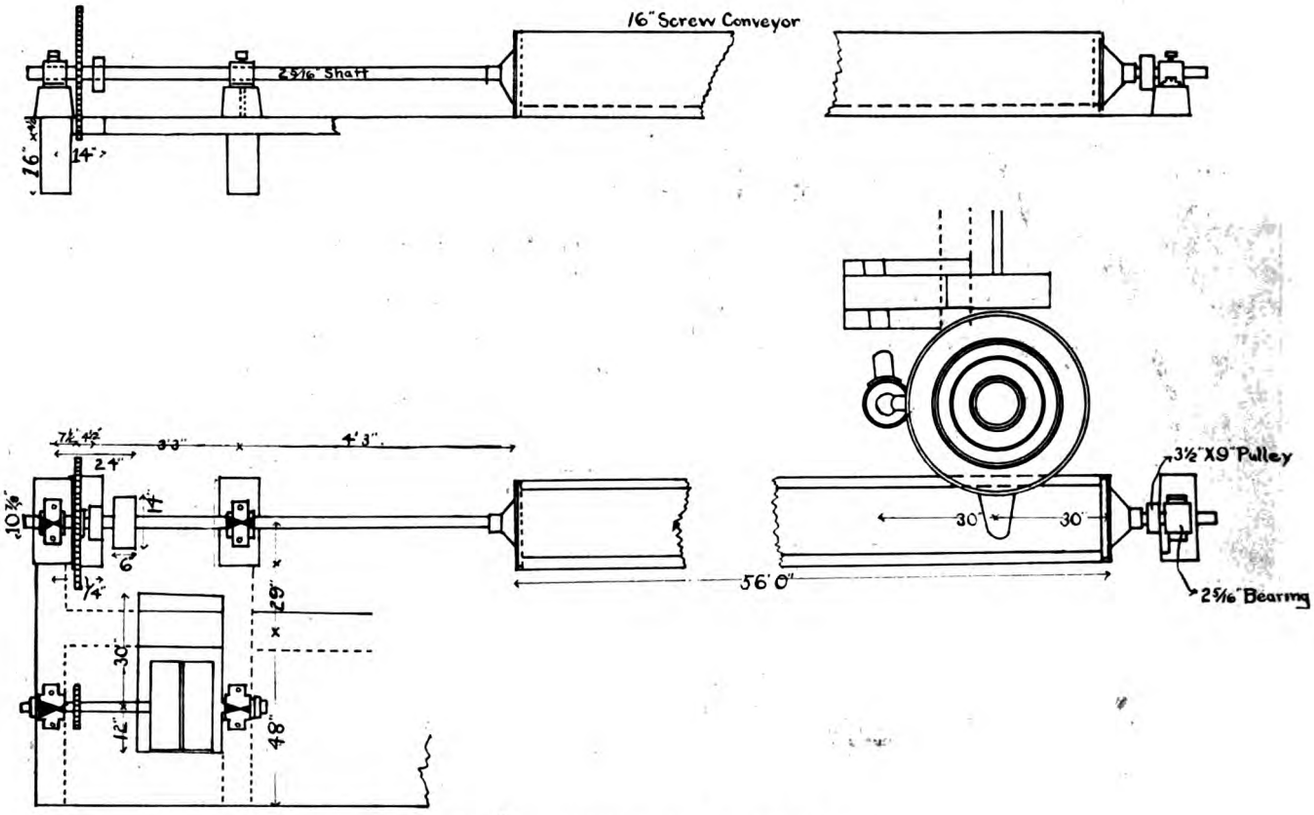

FIG. 5. DETAILS OF CONVEYOR RESTING ON FLOOR.

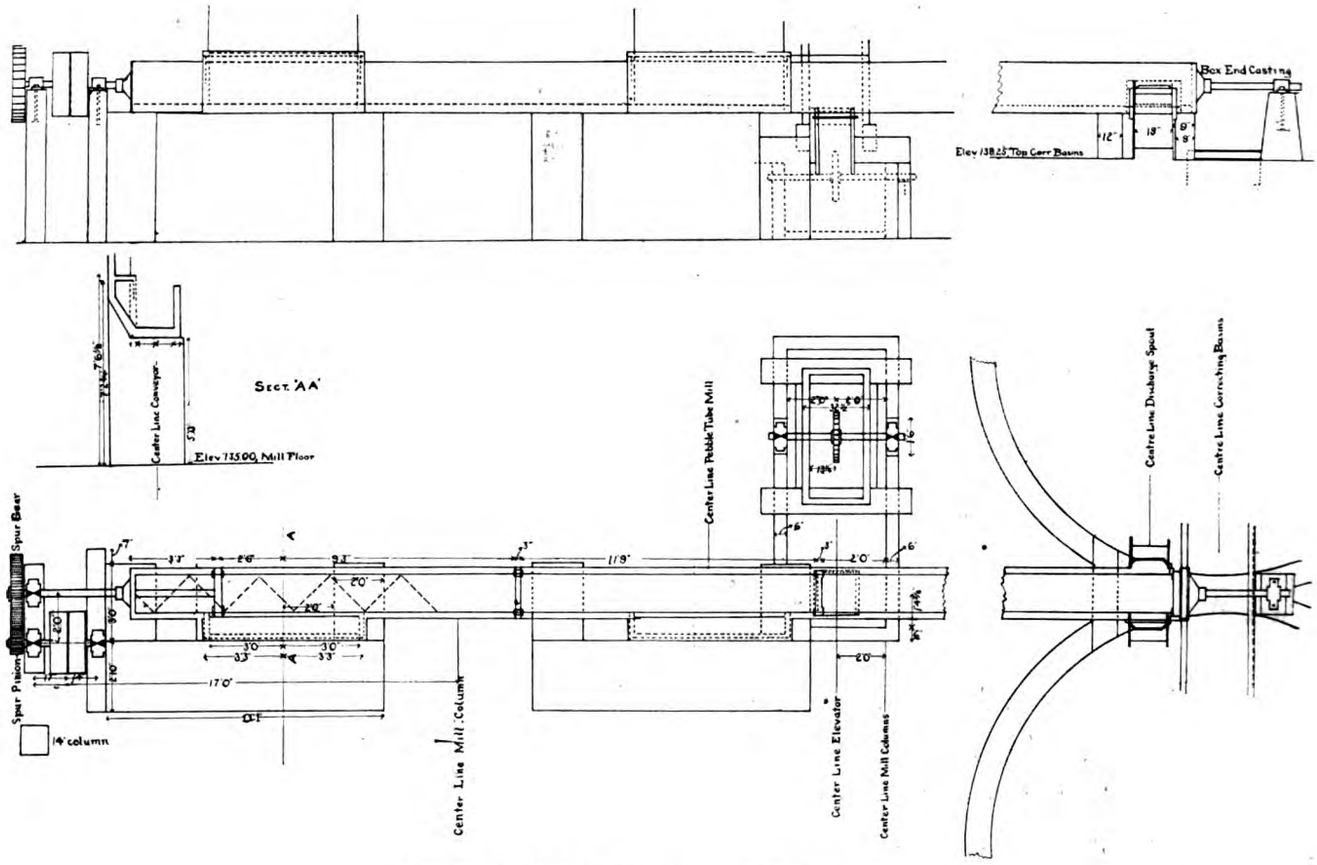

FIG. 6. DETAILS OF CONVEYOR RESTING ON PIERS.

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Fig. 5 and 6 show the plan and details of these. The side walls and bottom were made 3 in. thick and reinforced with ½-in. round bar securely tied to ⅜-in. stirrups. In Fig. 5 the conveyor rested directly on the floor slab, but in Fig. 6 it is supported by concrete piers about 5 ft. from the floor. Bolts were carefully set in the shell to attach the conveyor hangers, and ordinary cast iron conveyor box ends were bolted to the ends of the conveyor, through which the 2 15/16-in. shaft was carried to outboard bearings.

Special construction to connect to the splash casings of the tube-mills was required at each mill. In Fig. 6 and at the end, a double discharge casting, with slides on each side, was built into the concrete, enabling the slurry to be deflected into either slurry basin. In the centre, a cast iron spout was built into the bottom of the conveyor, which enabled the slurry to be sent up the concrete elevator and through the clypeb mill, or sent directly to the slurry basins, as desired.

These conveyors handle slurry containing about 33% of water and are waterproof, and very satisfactory in operation and appearance. For both the elevators and conveyors, a wet mixture of concrete mixed in proportion of 1 cement, 2 sand, and 3 of pea gravel was used, without any waterproofing material.

Fig. 7 shows the discharge end of a concrete screw-conveyor. Fig. 8 shows the 16-in. screw and hangers in position before the cover was in place.

The writer designed and supervised the construction of both the elevators and conveyors for the Vancouver Portland Cement Co., Limited, of Victoria, British Columbia.

Low Bids on Street Paving at Portersville, California

The following bids were opened at Portersville, California, on February 8, for the construction of 33 blocks of street pavement with concrete foundations and Topeka specification wearing surface:

	Paving.	Grading.
Federal Construction Co., San Francisco	$0.1283 per sq. ft.	Included in paving.
Sunset Paving Co., Hanford	0.115 " " "	$0.50 to $0.85 per cu. yd.
A. C. Root, San Francisco	0.13 " " "	0.20 per cu. yd.
Blanchard-Brown Co., San Francisco	0.145 " " "	0.30 " " "
Ransome-Crummey Co., Oakland	0.1475 " " "	Included in paving.
Thompson Bros., Fresno	0.123 " " "	0.01 per sq. ft.
McGilvray Construction Co	0.142 " " "	0.01 " " "
Teichert & Son	0.143 " " "	0.50 per cu. yd.
Clark & Henery Construction Co., Sacramento	0.138 " " "	0.01 per sq. ft.
Worswick Construction Co	0.1275 " " "	0.65 per cu. yd.

One of the contractors present at the opening of the bids characterized them as "the lowest ever offered a city for street paving work in the history of the Pacific coast." Similar pavement, but of asphalt-macadam, has cost the city about 25c. per square foot, showing very clearly the large saving to the taxpayer which the Topeka specification is making. While it is true that general business conditions have been recently the cause of much brisk competitive bidding among contractors, still that alone would not explain cutting the cost of paving practically in two. By the saving of a large royalty, however, the contractor is enabled to construct a durable pavement at a much lower cost. Probably a reduction in the cost of street pavement is of more far-reaching effect than a similar reduction in the cost of other kinds of public work. For most public work, there is a definite appropriation, actual or implied, and a reduced cost means simply that more of such work can be done for the same money. Street work, on the other hand, is usually paid for, wholly or in part by the abutting property owners. There are a great many streets which sorely need improvement, but where the property owners cannot afford to pay around 25c. per square foot for pavement, but who would be very glad to pay 12 to 15 cents. Thus the property owner is benefited by a reduced price, the contractor and workingman by having more work, the manufacturer by a greater demand for his products, and the general public by the increased amount of good pavement.

An improvement in manganese steel alloys is announced in a recent United States patent. Commercial manganese steel contains from 11 to 14% of manganese, and hitherto any attempt to produce a steel lower in manganese than 10 to 11% has tended to make a metal nearly as brittle as glass and unfit for commercial use. The invention is based on the discovery, made by the inventors, that a certain critical relation exists between the percentage of manganese and the percentage of carbon employed with it in the alloy, and that by proportioning the carbon ingredient in accordance with this relation, a steel may be obtained containing from 6 to 9% of manganese, or as low as 5%, and possessing to a valuable degree the characteristic combination of ductility with hardness and the other important properties of the richer alloys. It is believed that there is a practical limit, around 5%, for the diminution of the manganese, according to the invention. The new alloy is a poor conductor of heat and practically non-magnetic.—*Canadian Engineer.*

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Methods of Construction of Fort Mason Tunnel*

The Board of State Harbor Commissioners, which controls the waterfront of the city of San Francisco, maintains the State Belt Line railroad running along the waterfront for the transfer of commodities from the wharves and between wharves. During the past year, this railroad has been extended from Powell street to the Exposition grounds at Laguna street, necessitating the driving of a tunnel through the hill on which Fort Mason is situated.

The tunnel is on tangent throughout. The entire project is a little over a mile in length, and the tunnel is 1498.5 ft. from face to face of portals. Fig. 1 shows a plan and profile of the tunnel.

The portion of the line from Powell street to Van Ness avenue presents no features of particular interest, the work consisting simply of light grading and some low trestles. A short distance west of Van Ness avenue the line enters the tunnel. The hill is steep on this side, so the approach cut was short, although a number of rock slides increased the yardage considerably. One slide in particular contained about 2000 cu. yd. and delayed the work several days. The western approach was longer and the material was sand. Besides the approach itself, 474 ft. of tunnel from the west portal easterly was excavated as open trench and then concreted and backfilled. The excavation for this part of the work ranged from 42 to 65 ft., and the material was mainly sand. A well-drilling machine was used to drill 12-in. holes along the side lines of the cut. These holes were spaced 10 ft. centres and were drilled to subgrade. In these holes were placed 10 by 12-in. timbers. As the excavation progressed, 3 by 8-in. or 4 by 8-in. pieces af sheathing 12 ft. long were inserted behind the timbers, and spreaders of 10 by 12-in. and 12 by 12-in. stuff were used where necessary. This way of handling the sandy formation proved entirely satisfactory. The bulk of the open excavation on the western end was made with a 1-cu. yd. clam-shell bucket, and the material was hauled away in motor trucks, most of it being sold for filling land at various points.

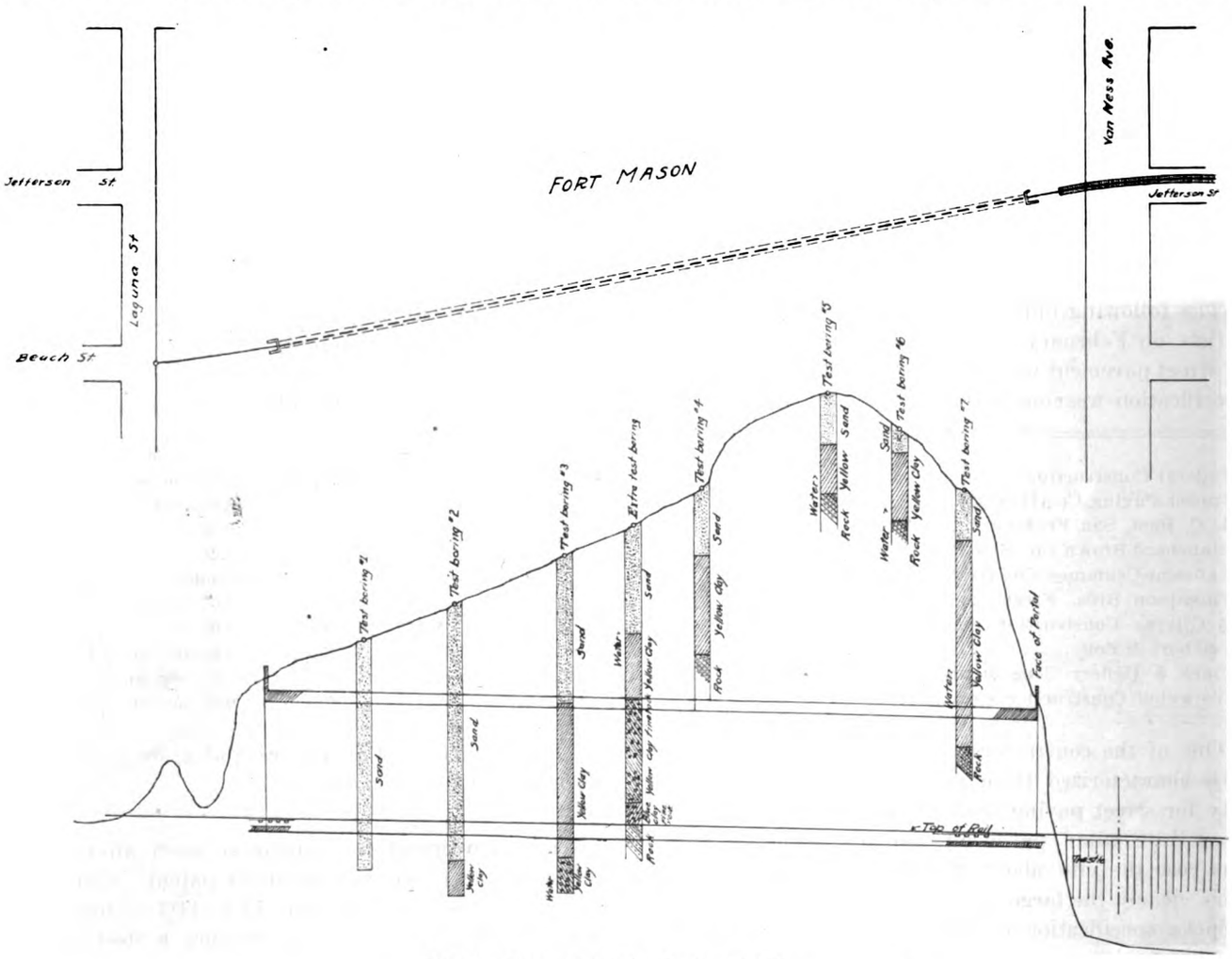

FIG. 1. PLAN AND PROFILE OF TUNNEL.

*Staff article.

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The tunnel section is shown in Fig. 2. Starting from the west portal, about 400 ft. of the distance was in sand, about 150 ft. in clay, and the remainder of the tunnel in sandstone, serpentine, and diabase. For about 1000 ft. on the east end, considerable trouble was experienced from water. In driving the tunnel, hand

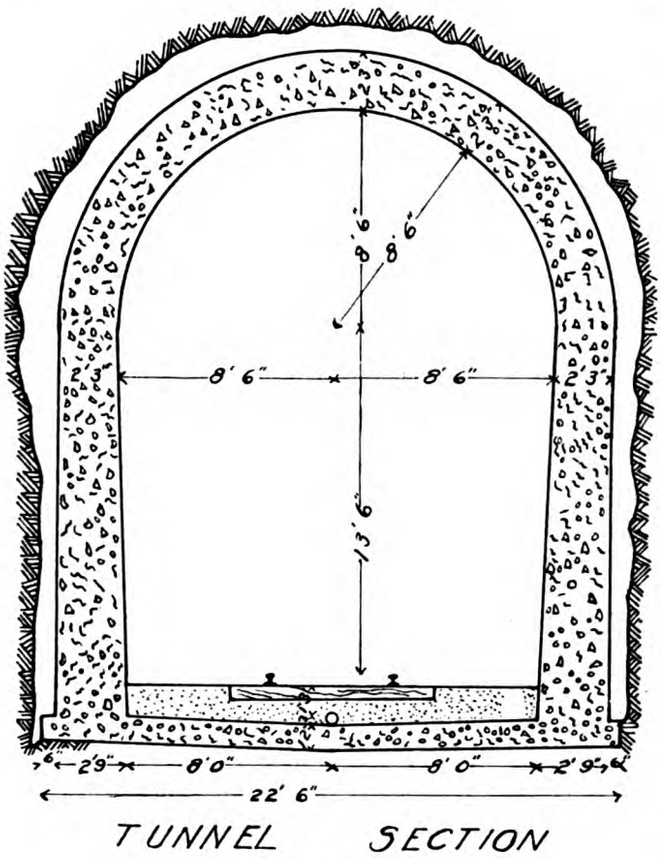

FIG. 2. CONCRETE TUNNEL LINING.

drilling was used entirely. The size of the heading corresponded approximately with the portion of the completed tunnel section above the spring line. In driving the tunnel, what is commonly called the 'American' method was used in general. Small drifts on each side at the bottom of the heading were driven far enough ahead to admit of setting a wall-plate, usually 18 to 20 ft. The drifts were enlarged and widened toward the centre of the section, and the segments of the arch placed until all the timbers of the 5-segment arch were in position, resting mainly on the unexcavated core of the heading. The core of the heading was then removed.

Work on the bench followed within 50 or 100 ft. Small excavations were made beneath the wall-plates until room enough was obtained to set a post under the wall-plate, whose bottom was at sub-grade. In most cases it was necessary to set a shorter post first to support the wall-plate until the material could be excavated to sub-grade and the full-sized post set. When posts had been set under the wall-plates on both sides, the bench in between was taken out by drilling vertical holes a short distance back of the face of the cut. To expedite the work, a 12 by 12-ft. shaft was sunk about midway of the tunnel, and headings were driven both ways from the shaft until they met the open-trench work on the west end and the heading from the portal on the east end. Excavated material was removed from the tunnel in dump-cars hauled on industrial track by animal power. The material from the shaft was disposed of in the same way as that from the west approach. The material from the east end of the tunnel was used for a fill on the line a short distance east of the portal.

A 1:9 mixture of concrete was used throughout for lining the tunnel. Each batch was composed of 1½ sacks of cement, 1½ cu. ft. of bank sand, 3 cu. ft. of Napa gravel, and 9 cu. ft. of No. 2, 3, and 4 crushed rock. By actual measurement, 3.78 sacks of cement was used for each cubic yard of concrete. As is shown in Fig. 2, the lining of the invert was 12 in. thick; at the sides it was 2 ft. 9 in., diminishing to 2 ft. 3 in. at the spring line, which was also the thickness of the arch. Concreting was carried on from the portal and from the shaft at the middle of the tunnel. At this shaft, which was about 30 ft. deep, 12-in. holes were drilled and iron pipe inserted. Concrete was 'chuted' to the tunnel through these pipes and conveyed from there to the forms. At the east portal, the concrete was hoisted to a hopper above the roof and from there conveyed by a gravity tramway to the forms. Concrete for the invert and walls was dumped and for the arch shoveled into place.

Bates, Borland & Ayer, Crocker building, San Francisco, were the contractors on the work. J. H. Wilson was the superintendent and S. F. Lloyd the engineer. L. D. Smith was the resident engineer for the Harbor Commissioners, under Chief Engineer Newman. Work was commenced March 13, completed and track laid on October 21, 1914.

Following is a summary of the principal quantities and unit prices to the contractor. Figures are for the entire project from Powell street west.

Tunnel excavation:	
Earth (824.5 lin. ft. at $76)	$ 62,662.00
Rock (670 lin. ft. at $76)	50,920.00
Open-cut:	
Earth (10,940.8 cu. yd. at 60c.)	6,564.48
Rock (824.1 cu. yd. at $1.25)	1,030.12
Earth backfill (8039.2 cu. yd. at 60c.)	4,823.52
Arch concrete tunnel lining (4775.87 cu. yd. at $9.50)	45,370.76
Side walls and invert concrete tunnel lining (6193.1 cu. yd. at $6.50)	40,255.15
Concrete in portals (568.4 cu. yd. at $9.50)	5,399.80
Concrete in retaining walls (1443.2 cu. yd. at $6.50)	9,380.80
Trestle (1424.13 lin. ft. at $9.50)	13,529.24
Laying and ballasting track (4314.49 lin. ft. at $1.65)	7,118.90
Riprap (5497.06 tons at $1.50)	8,245.59
	$255,300.36
Bonus for completion ahead of time, 59 days at $100	5,900.00
Extras	11,929.64
Total payment to contractor	$273,130.00

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Highway Improvement Project, San Bernardino County, California

The San Bernardino County Highway Commission, consisting of Messrs. J. B. Gill, chairman; W. A. Freemire, and George S. Hinckley, secretary, prepared a report to the San Bernardino County Board of Supervisors as a basis for a road bond issue which was approved by the voters at an election held October 20 last. Through the courtesy of the Commission, we are able to present the following extract from the report showing the mileage and descriptions of the sections of road to be improved.—EDITORS.

Immediately after our organization, we made a careful study of all the principal highways within the county, with the idea in view of locating the highways to be improved where they would best serve the people of the county. We submit for your consideration and approval the following highways to be improved under an estimated bond issue to the amount of $1,750,000:

Mileage.	*Description of Road.*
6.75	(1) Base Line from San Bernardino city limits east to a point about ¼ mile east of the southwest corner of section 34, T. 1 N., R. 3 W.; thence south and east *via* Cram road to Church street at East Highlands.
6.50	(2) Highland avenue from San Bernardino city limits to Church street at East Highlands at a point ½ mile north of Base Line.
0.56	(3) Mountain avenue from Highland avenue north to the south side of Santa Fe railway at Del Rosa.
1.00	(4) Palm avenue from Base Line to Highland avenue at Highland.
1.30	(5) Church street at East Highlands from Cram road north to a point ½ mile north of Base Line.
1.30	(6) Orange street from Cram road south to the north end of the bridge nearest Redlands.
7.50	(7) From Redlands city limits east on Citrus avenue 1 mile; thence north 1 mile to Lugonia avenue; thence easterly to the mouth of Mill Creek cañon.
1.00	(8) Mentone avenue from east city limits of Redlands to Crafton avenue.
5.50	(9) From Redlands city limits in Reservoir cañon southeasterly to the Riverside County line on the south line of section 11, T. 2 S., R. 2 W.; to connect with Riverside County road at that point.
5.00	(10) From a point on road No. 9 in section 6, T. 2 S., R. 2 W.; near the entrance of Reservoir cañon, to approximately the northeast corner of section 5; thence east to Yucaipa city.
1.25	(11) From the corner of Barton road and the San Timoteo Cañon road, 1¼ miles southeasterly on the San Timoteo Cañon road.
4.75	(12) From Redlands city limits on Brookside avenue *via* Barton avenue through Redlands junction west to Anderson (or Mound City) avenue; thence north around Loma Linda hill to Colton avenue.
5.50	(13) From and connecting with road No. 12 at Loma Linda; thence westerly along or near the present Riverside Bluff road to and connecting with Colton avenue.
5.50	(14) From the corner of Barton road and California street north to Cottonwood road; thence along Cottonwood road to Mountain View avenue; thence north on Mountain View avenue to Victoria avenue; thence west on Victoria avenue to Tippecanoe street, north on Tippecanoe to Mill street; thence west on Mill street to San Bernardino city limits.
6.90	(15) From Redlands city limits west on Colton avenue to Colton city limits.
1.70	(6) South 'E' street from San Bernardino city limits to Colton avenue.
1.70	(17) Colton avenue from San Bernardino city limits *via* Urbita to Mt. Vernon avenue.
0.70	(18) Mt. Vernon avenue from San Bernardino city limits 1.40 miles to Colton avenue. This road is one-half in the county and one-half in the city of Colton and will be paved provided the city of Colton pays one-half the expenses of such pavement.
2.70	(19) Colton avenue from Colton city limits southerly to the Riverside County line.
17.00	(20) Colton avenue from Colton city limits west to Archibald avenue; thence south ½ mile; thence west to Ontario city limits.
2.60	(21) Cedar avenue in Bloomington from Colton avenue south to the Riverside County line.
7.00	(22) Etiwanda avenue from Highland avenue south to the Riverside County line.
3.50	(23) Archibald avenue from Base Line to Colton avenue.
4.50	(24) Archibald avenue from the Ontario-Riverside state highway south to the Riverside County line.
2.00	(25) Turner avenue from Colton avenue south to the Ontario-Riverside state highway.
8.50	(26) Euclid avenue from Ontario city limits south to southerly line of the Chino grant; thence easterly along the south line of grant 1 mile; thence south ¾ mile to the township line; thence east to the county line.
0.70	(27) From east end of road No. 26, south along the Riverside County line 1.40 miles. This road to be improved provided Riverside county pays one-half the cost.
4.40	(28) Central avenue, Chino, from city limits south and southeasterly to connect with south end of Euclid avenue.
2.30	(29) Central avenue from Chino city limits north to state highway (Holt avenue).
1.25	(30) Chino avenue from east city limits of Chino to Euclid avenue.
2.70	(31) Silo avenue from Chino city limits west 0.90 miles; thence north 1½ miles; thence west 0.30 miles to Los Angeles County line.
4.30	(32) Silo avenue from Chino city limits east to Archibald avenue.
3.00	(33) Tenth street, Upland, from west city limits to Los Angeles County line.
0.60	(34) Tenth street, diagonal extension, from Upland city limits northeasterly to the state highway.
2.50	(35) Mountain avenue from Twelfth street to Twentieth street (Upland).
2.70	(36) Nineteenth street (Olive avenue), Upland, from the city limits east to Amethyst street; thence south through Alta Loma Base Line (Palm avenue); thence east to Archibald avenue.
5.50	(37) Olive avenue from Amethyst street east to the west line of section 36, T. 1 N., R. 7 W.; thence north to Highland avenue, east on Highland avenue to Etiwanda avenue.
11.00	(38) Highland avenue from Etiwanda avenue east to Mt. Vernon avenue. The Supervisors have agreed to build a bridge across Lytle Creek wash.
1.50	(39) Riverside avenue, from Rialto city limits north to Highland avenue.

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Mileage.	*Discription of Road.*
1.30	(40) Riverside avenue from Rialto city limits south to Colton avenue.
2.25	(41) Perris avenue (Rialto avenue) from Rialto city limits east to San Bernardino city limits.
1.70	(42) Bloomington avenue from Rialto city limits southwesterly to Colton avenue.
2.10	(43) Magnolia avenue from Perris avenue south to Colton avenue in Fontana.
0.50	(44) Rancho avenue south from Perris avenue to Colton city limits.
1.30	(45) Mt. Vernon avenue from San Bernardino city limits north to Highland avenue; thence east on Highland avenue to San Bernardino city limits.
3.30	(46) From San Bernardino city limits on Arrowhead avenue northerly to Waterman cañon, to the point where the road forks at the Hotel road.
22.00	(47) From junction of Highland avenue with Mt. Vernon avenue to summit of Cajon pass *via* Devore.

Total mileage of roads in valley and to the summit of Cajon pass, 187.11.

The Board of Supervisors has unanimously agreed to build from the general fund of the county the following roads:

Tenth street, in the cities of Upland and Ontario from Euclid avenue west to the west city limits of Upland;

Mountain avenue in Upland north from Tenth street to Twelfth street;

San Bernardino avenue through the city of Rialto from west to east limits thereof, connecting the state highway;

All aggregating three and one-half miles.

Miles.	*Desert Roads.*
240.00	From summit of Cajon pass to the state line near Needles *via* Hesperia, Victorville, Oro Grande, Barstow, Ludlow, and Needles. The desert's share of this bond issue is approximately $125,000, and the Commission recommends that this amount be spent between the summit and the state line near Needles.

Between the summit and the Colorado river the distance is so great that the money available must be spent at the points where it will make the most permanent improvements; this will give a satisfactory road to accommodate the amount of travel which it will have.

In a few cases there are rights of way to be obtained, and the Commission requires that such rights of way be secured by the communities interested in these roads without expense to the Commission.

We estimated the average costs of these roads in that portion of the county south of San Bernardino mountain to be from $7000 to $10,000 per mile, including the necessary culverts, none of which are large or expensive, but we recommend that these be of a permanent nature.

The fact that we have an abundant supply of rock, gravel, cement, and other road material close at hand, and the experience of the state and adjoining counties in the work, leads us to believe that the above figures are a reasonable estimate of cost. It is our opinion that all the road materials should be purchased by the county and furnished to the contractors, and that wherever it is found that the work can be done to advantage and more economically by doing it direct instead of contracting, the work be so done.

In the adoption of the above system of highways, the Commission has endeavored to select, in addition to the main thoroughfares connecting with the principal cities and centres of population of the county laterals which will connect with these main thoroughfares, the state highway and the main highways of adjoining counties, thereby affording the farming communities the best possible means of marketing their products and in a general way to aid in the development of the country as a whole.

It may appear that the Commission has incorporated unnecessary highways, thereby increasing the cost without adequate return, but, when it is taken into consideration that the highways are being built for the future development and growth of the entire county, and that another bond issue of this character will not be promulgated for many years to come, the reason for including such roads herein shown becomes obvious, and further, with increased population occasioned by good roads, it means correspondingly an increase of assessed valuations. It would be manifestly unfair not to include all portions of the county that admit of further development.

After a most careful investigation of the different types of permanent road construction, we recommend that none of the paved roads be less than 5 in. thick when completed. We would recommend that the Commission be given a reasonable latitude in the types and construction, and in no case will roads be built inferior to those now being constructed by the several counties. It is the intention of the Commission to build the roads of concrete and macadam, the type of each road depending on the local soil conditions.

Every effort has been made to give a fair and equitable distribution of the highways, and the citizens themselves in their respective communities have made their own selections, which when connected makes a very broad and comprehensive system of highways.

Your Commission has, to its utmost ability, diligently and conscientiously prosecuted the work of preparing a broad and comprehensive system of highways, especially adapted to the requirements of the county, an undertaking which at first was looked upon with a considerable degree of awe and apprehension.

When we reflect that the main trunk line extends approximately 300 miles from the Colorado river across the desert or mesa, and over the mountains to its connection with the Los Angeles County highway system, thence to the sea, together with the various ramifications, laterals, and diagonal highways, something of the prodigious character of the work can be realized, if not fully appreciated.

The Commission has in no instance acted arbitrarily in the selection of highways, but left the matter entirely to the citizens of each respective locality.

It should be the desire of our citizens to have equally as good if not better roads than our neighboring counties, and it is opportune to effect that result, as San Diego, Kern, Orange, Los Angeles, and Riverside counties have already voted bonds and are now building or have built complete systems of permanent highways.

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Unusual Foundation for Locomotive Exhibit at P. P. I. E.

By ARTHUR A. WILLOUGHBY

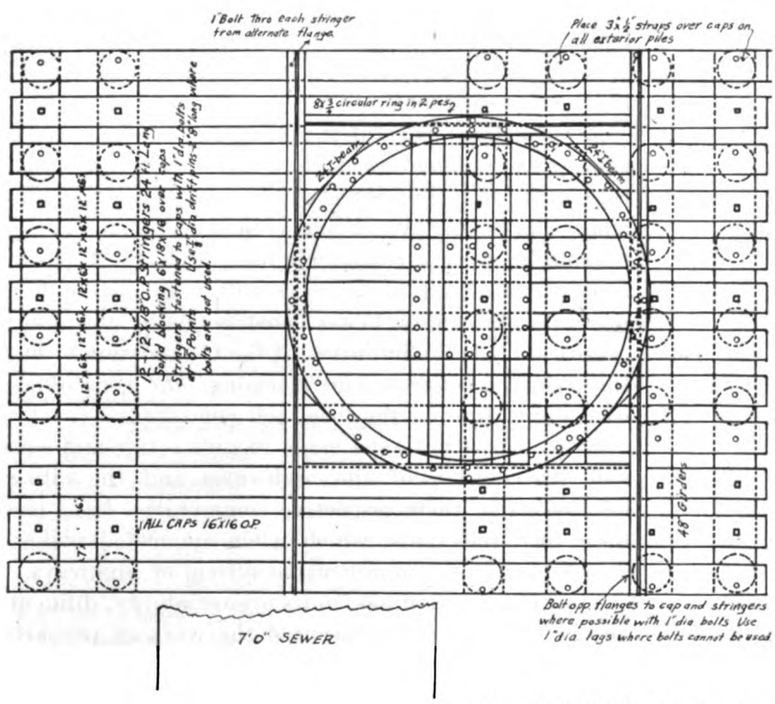
The use of pile footings in a very limited space for a concentrated loading involved some interesting engineering details in the design of the foundations for the turntable used in the Palace of Transportation at the Panama-Pacific International Exposition.

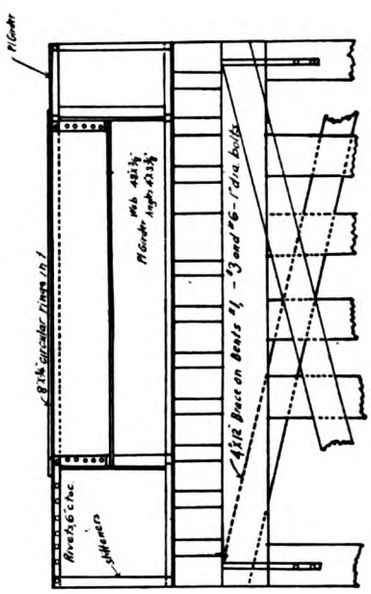
A Westinghouse electric locomotive of the articulated type used by the Pennsylvania railroad in the Hudson River tunnels, has been placed on a deck turntable of standard American Bridge Co. design, and used as a decorative effect in the rotunda of the building. The weight of the locomotive, 156 tons together with the supporting structure, necessitated unusual foundations. The design had also to be based on the fact that the structure was to be removed after the Exposition period, including the foundations to a depth of four feet below the surface.

Owing to the presence of a brick subway, 9 ft. wide, nearly in the centre of the space from north to south, it was necessary to group the piles so that the centre of gravity of the loads would agree with the centre of gravity of the pile reactions and the vertical reactions to balance. The closeness of the piles to each other is unusual, there being a distance between centres of 24 in. The piles are 16 in. diameter at the butt. The space available for the foundations was 17 ft. 7 in. by 24 ft. 9 in., and in this space 36 piles were driven through the underlying strata of silt, sand, and clay to one-inch penetration at the last blow of the driver. Four rows of six piles each were used on one side of the subway, and two rows of six each on the other side.

A foundation girder 11 ft. 3 in. square, and made up of built-up girders 4 ft. deep, was set on the stringers. Four 2-ft. I-beams set in the structure carry the steel base-plate, 48 in. square and ¾ in. thick.

The turntable is a large deck-plate girder 65 ft. long and having a maximum depth of 72 in. at the centre and a minimum depth of 36 in. at either end. It is supported on a large roller bearing, made up of 20 steel conical rollers, 10⅚ in. long, having end diameters of 5¾ and 2⅞ in. respectively. The rollers will carry a maximum load of 500 tons. The foundations have been designed for a load of 540 tons.





PLAN AND ELEVATION OF FOUNDATION.

An incline track was built to get the locomotive onto the turntable, which was heavily blocked up. The top of the rail on the turntable is 12 ft. above the floor. The turntable is revolved by means of a rack and pinion drive from an electric motor driving through reducing gears so that one revolution per minute is made of the structure. Special illuminating details have been used in lighting.

The foundation was designed by H. J. Brunnier, consulting engineer, Sharon building, San Francisco, and installed by Duncansson & Harrelson, contractors, Chronicle building, San Francisco. The turntable was designed by the American Bridge Co. A. M. Hunt, Nevada Bank building, San Francisco, was consulting engineer.

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Sand and Gravel Deposits of the Puget Sound Territory

By R. J. BORHEK*

The most extensive and valuable sand and gravel deposits on Puget Sound were formed by the outwash of the Vashon glacier moving south from British Columbia. This vast glacier field, with a total frontage of eighty miles, was divided into two lobes by coming into contact with the Black Hills on the southern Sound shore front. The westerly or Shelton-Matlock area of 150 square miles rises to a level of 300 ft. above the sea. The great Steilacoom plain, the north arm of which extends to the Puyallup valley at Orting, south to Centralia, and west to Gate, covers an area of 350 square miles. The Wilderness area of gravel, 30 square miles, lies between Green and White rivers, and is a stratified deposit marked with terraces, 300 to 500 ft. elevation, composed mainly of large pebbles and boulders. The Clover Creek-American Lake area, adjacent to Tacoma, covers an area of 150 square miles, and is the best known part of the Steilacoom Plain deposit. On the formation of the east and west lobes of the Vashon glacier smaller gravel deposits filled the depression south and east of the Black Hills, the present valley of the Deschutes, Chehalis, Satsop, Skookumchuck, and Nisqually rivers.

The Steilacoom plain, extending from the limits of South Tacoma, has a general southeast and southwest direction, the southwest exposure terminating at the bluffs of the Sound, two miles north of Steilacoom. The general elevation is 250 ft. above tide-water. The deposit is composed of outwash gravel, clean and fresh, hard and well rounded pebbles, graded from fine to coarse, few being above commercial size. The sands are well graded, dark gray in color, clean and sharp, showing no evidence of disintegration or silt particles. The westward end of the deposit terminates in a bluff, rising abruptly to an elevation of 200 ft. above the Sound. Between the north and south exposures is an area three miles long, one mile wide, covered with stratified drift. From here to the Nisqually river, a distance of three miles, the deposit fronting the bluff rises to an elevation of 180 ft. and is composed of clean, well rounded pebbles, though containing an excess of larger sizes and some boulders, probably due to the delta formation at the mouth of the Nisqually river. The entire bluff face has a westward dip of 15° toward the Sound. Rolling terraces parallel to the above front are found rising ten to twenty feet above the general level, probably made by wave action, as the material was deposited in rising water. The general surface rises ten to fifteen feet per mile to the east. The sand and gravel in the deposit is at least two hundred feet thick at the bluff front, and gradually thins out to the east and south. Between Steilacoom and Owaga, three miles south, volcanic ash and lava pebbles are exposed along the Northern Pacific Railway cut. The pebbles are so soft that they can be crushed between the fingers.

In its retreat north the Vashon glacier deposited a veneer of sand, clay, pebbles, and boulders over the entire area to the north, covering the summits of the inter-glacial hills. This is shown by the deposits on Anderson, McNeills, Fox, Vashon, and Bainbridge islands, and along the east shore of the Sound from Tacoma north to Seattle. In places, the retreat left as deltas and outlet channels, well defined deposits of sand, gravel, and clay, regularly stratified in the direction of stream flow. Old drift underlies the Vashon glacial deposits to the south at Centralia and west to Aberdeen. Throughout this section red and decayed gravels are common, somewhat similar in appearance to the Orting gravels. The larger pebbles are often soft and easily ground under ordinary road traffic. The Mima plains present a unique appearance, being covered with mound-like forms, rising three to ten feet above the general surface, dome shaped, containing small pebbles, sand, and a covering of loam. Between these mounds are beds of coarse gravels and boulders almost devoid of sand. Lava pebbles, gray, green, orange, yellow, and red, are found banked up in places along the shore front south and west of Tacoma. They are soft and often flattened in the shape of shingle, the tidal action piling them up in bars and ridges. A well defined line between two glacial epochs is shown at Point Defiance Narrows, where clean banks of fine gray sand underlie the drift. The thickness is about 200 ft., and the sand is fine and compact. The south end of Vashon and Maury islands show these sands exposed to heights of 250 feet.

The Tacoma Delta and McKinley Hill gravels, elevation 250 ft., dip north and east toward the Sound. The surface can be traced south with a raise of ten feet in a few blocks. The beds are ten to sixty feet thick, with a thin veneer of glacial till. Toward the Puyallup valley the deposit thins out rapidly.

In the northern limits of the city of Tacoma the sands are of the same quality, clean and fine, having a thickness of two to three hundred feet. This same deposit is in evidence at the south end of Vashon island and again in the East Sound shore below Fauntleroy park, ten miles below Seattle.

The local deposits in the city of Tacoma are all in the McKinley Hill district, where a veneer of stratified drift overlies good commercial gravels to a depth in places of thirty to fifty feet. The striking feature of this deposit is the presence of two distinct kinds of sands, one fine, clean, and sharp, the other coarse and soft. On the Sound side of the deposit, disinte-

*Contracting Engineer, Tacoma, Washington.

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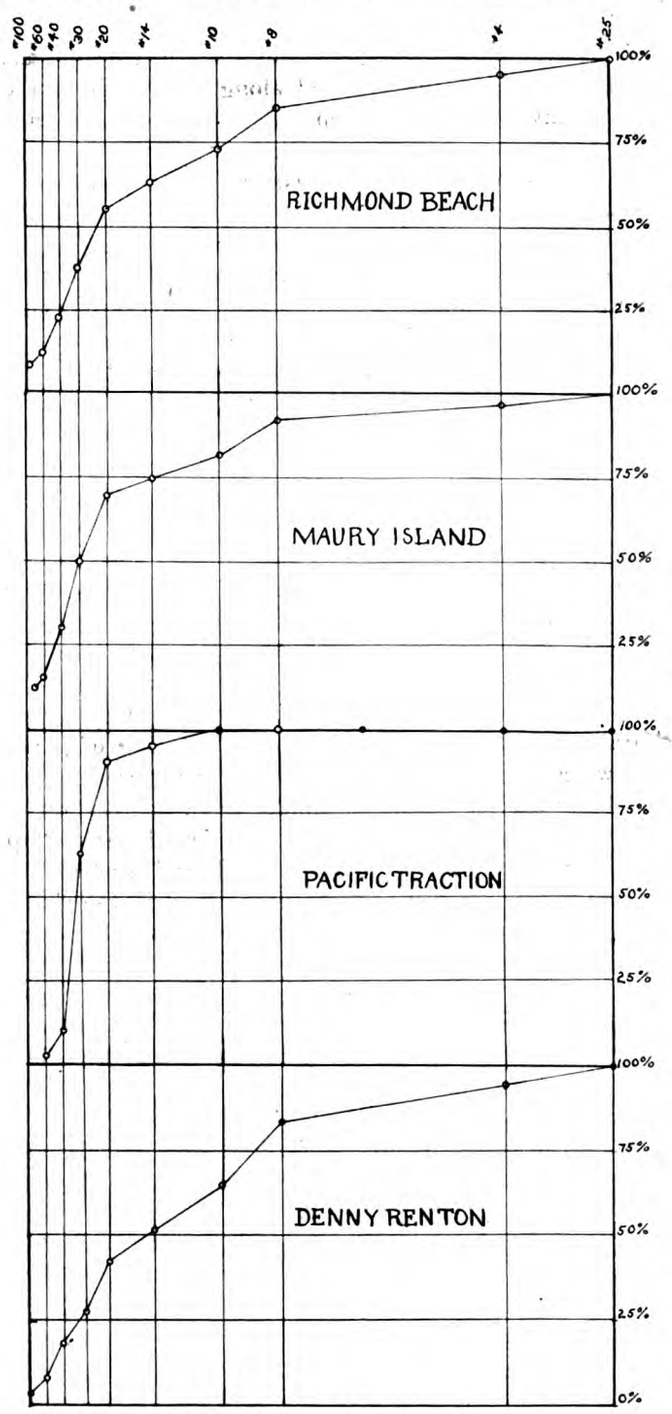
grated granite boulders and coarse gravels predominate. Toward the west the deposit is well graded, similar to the Steilacoom gravels. These deposits are generally shallow and do not have working face



SCREEN TESTS OF TYPICAL GRAVELS.

enough to permit the hydraulicking process. The method of operation is to use a drag-line excavator, the material being dumped in a sump, from which it is raised by a belt-conveyor to bunkers and screened and washed. On account of the shallowness of the pits, the large area covered, and the method of elevating and screening, the cost of production is high, amounting to 25 to 30c. in the bunkers.

In several small pits in the Cedar River district, south of Seattle, a similar method is used, taking the material from the river bed and adjacent banks. The deficiency of sand and the excess of coarse gravel and boulders make these plants costly of operation. Sluicing operations are also carried on in this district, but the material in the hillsides generally contains so much clay as to produce an unsatisfactory material.

Gravel pits are found on both sides of the valley at Renton in exposed forest beds, dipping toward Cedar river and lying against the higher till-covered slopes, containing clay, shale, and sandstone. Kennydale delta along the eastern bluff of Lake Washington presents more novel features than any of the above described deposits. May creek, flowing through these gravels, has cut a channel 200 ft. deep to the underlying strata of boulder clay. On the south side of the creek the slopes are abrupt, benching off at elevations of 150 and 250 ft., respectively. The deposits on either bank are generally stratified parallel to and dip rapidly toward the stream bed. They are composed of coarse gravel and fine pebbles in almost equal proportions. The sands are generally coarse, formed by disintegrated granite, and contain a scattering of clay balls. The deposit is washed clean in places, particularly where the small pebbles predominate. Streaked with blue sands and boulder clay, the stratification is much broken and possesses no continuity. Generally along the hillsides there is a covering of ten to twenty feet of Vashon till, and underneath are beds of sand up to fifty feet in thickness. Along the Chicago, Milwaukee & Puget Sound Railroad, exposures show ten to fifteen feet of yellow and brown sand, underlain with twenty to fifty feet of coarse blue sand and boulder clay. South of the Kennydale area, at an elevation of 200 to 300 ft., is a broken-faced deposit of sand and gravel ten to thirty feet thick, covering a distance of several miles to east and south. Kame terraces at Green lake, Lake Union district, in Seattle, are heavily covered with gravel from sources to the north and east. There are numerous open pits in this district, covering several acres, the beds being generally ten to twenty feet thick, underlain with clay and boulders. The half dozen or more pits within the limits of the city of Seattle are situated in drift areas and contain stratified sand, gravel, and clay in almost equal proportions, shallow in extent, and serve as a temporary supply for work close at hand.

At Richmond Beach there is a narrow elongated deposit one-quarter to one-half of a mile wide and several miles long. It rises to 165 ft. above Sound level. One-eighth of a mile south of the present pit opening, a bleached kettle interrupts the continuity of the bluff. The gravel is of forest Vashon deposit with Vashon till exposed beneath. Fine sand, intermingled with boulders, composes the body of the deposit, being streaked here and there with beds of small clean pebbles. It covers about twenty acres of commercial sands and gravels. The excess of sand and

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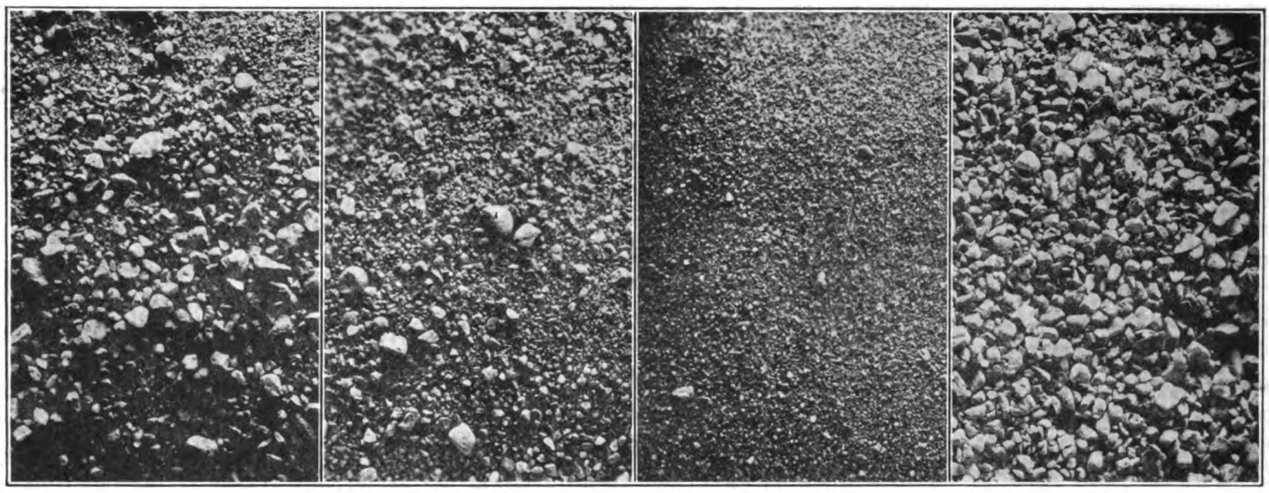
coarse gravels make the cost of operation rather high for a hydraulicking pit. The average proportions here are about 20% commercial gravel to 80% sand.

Steilacoom plain, ten miles south of Tacoma, has the largest deposit and is the centre of the industry. Rising from the level of the Sound to 200 ft., these deposits contain almost equal amounts of salable sand and gravel. The material is so clean and well graded that little, if any, is rejected on account of oversize, and crushing is unnecessary. On account of the natural grading of these deposits, the cost of operation is small, amounting, when running at full capacity, to not more than 8c. per cubic yard on the scows. The sluicing process is used, water being pumped to the face of the pit, and the material washed back through steel-lined flumes to the bunkers where the material is separated and washed, the different grades passing to the respective bins. Under-feed gates charge the cars, which are hauled to the end of the dock and discharged automatically to the scows below. The material averages 40 to 50% sand and 50 to 60% gravel. In spots the delta deposits have considerable oversize material, from 10 to 20% being rejected. The sands are clean and sharp with good assortment of sizes, and show no traces of disintegration or presence of clay. The gravels are fresh in appearance, with hard, well rounded pebbles.

In the Sherlock delta there are coarse gravels and fine sand, mingled with silt and loam. The pebbles are well rounded, hard, and of fresh appearance. The deposit is overlain with stratified drift composed of coarse gravels, boulders, and boulder clay. In the Auburn delta the deposit rises to an elevation of 250 ft., showing several well defined strata, the higher elevation containing coarse gravel with fairly clean, well rounded pebbles. The dip west contains softer sands and decomposed granite.

At Maury island, midway between Seattle and Tacoma, the eastern slope rises abruptly from the Sound to a point 300 ft. above tide-level. The under strata are composed of hard blue boulder clay, streaked with sand, and underlain with 200 to 250 ft. of fine compact sand which is streaked with clay seams almost totally devoid of gravel. The upper surface is composed of a layer of fine stained gravel, thirty or forty feet deep in some places. The average gravel content of the bank does not exceed 10 to 15%. The entire eastern slope is covered with Vashon drift, containing gravel to a depth of ten to fifteen feet north of the present opening. In the broken places formed by old watercourses, the gravel is found to a depth of twenty to twenty-five feet, as shown by test pits. Underneath this is sand to a depth of 200 to 250 ft. Exposures on Vashon island show sand beds two hundred or more feet in thickness, covered with drift.

The sand and gravel business is becoming one of the leading industries of Puget Sound and the Canadian Northwest. The deposits are within permissible water transportation distances of the Sound cities, Olympia, Tacoma, Seattle, Bremerton, Everett, Bellingham, Victoria, and Vancouver, making this material available for all classes of construction work. At the present time the above mentioned cities consume from 600,000 to 700,000 cu. yd. per year, with the consumption growing at a rate of 100,000 cu. yd. per year. From the above mentioned sources, somewhat in excess of 5,000,000 cu. yd. has been removed.



SAMPLES OF TYPICAL GRAVELS. FROM LEFT TO RIGHT, RICHMOND BEACH, MAURY ISLAND, PACIFIC TRACTION, AND DENNY RENTON.

The capacities of the various plants are as follows:

	Gravel, yd.	Sand, yd.	Total per day, yd.
Pioneer	2500	500	3000
Owaga	800	200	1000
Tacoma	900	900	1800
Richmond Beach	200	500	700
Vashon	150	550	700
Maury Island	50	300	350
Lake View	150	50	200
Green Lake	100	100	200
North Point	100	150	250
Cedar River	150	100	250
East Renton	100	50	150
Harrison Bros.	100	100	200

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The total amount invested is large, the lower sand companies having invested $500,000 or more, exclusive of their city properties. Many of these have their own towing equipment and facilities for city delivery.

The sands tested include all those in general use, together with a few from isolated pits where the deposit was small and rapidly being exhausted. The mineralogical composition of the sands tested is quite variable, the presence of hard and soft rocks, mica flakes, and organic matter having an important bearing on the strength of the mortars. The size and graduation of the grains, hardness, roundness, angularity, and roughness are all factors in its durability. The sands in general are composed of granite, quartz, basalt, shale, sandstone, andesite, and limestone, together with other rocks in varying percentages, the heavier and darker sands being generally low in quartz; the lighter sands, from the river deposits, higher in shale, sandstone, coal, bone, quartz, and limestone.

The effect of organic matter, due to improper stripping of beds, is illustrated in the case of the Lake View pit, where the strength of the mortar decreased 20 to 30% because of the presence of from 2 to 2½% of organic matter in the form of humus. This condition is also marked in the East Renton sand, where a thorough washing would contribute materially to the strength of the mortar. The sands from the Kame deposits on Lake Union (Seattle), Bothell, North Point, Lake Washington district show a high percentage of disintegrated granite, clay, and sandy loam, and the top beds generally show oxidation, stains from vegetable matter, and a rather high percentage of fine sand. The sands containing mica show a higher degree of porosity and lower strength compared with sands free from mica. The sands containing the greatest percentage of silt and organic matter are in general from the newer and smaller pits where the volume of overburden is large compared with the volume of the pit material. An extensive series of tests by the Tacoma Sand & Gravel Co., on Steilacoom gravels gave the following results for maximum density, grading the gravels from 3 in. to ½ in.; the 3-in. grade containing particles of all sizes from 3 in. to ¼ in.; the 2½-in. grade from 2½ to ¼ in., etc.

Mixture for maximum density:

3 in.	1:3½:7½	1½ in.	1:2¾:5½
2½ "	1:3 :7	1 "	1:2¼:4½
2 "	1:3 :6	¾ "	1:2 :3.6
		½ "	1:2 :3

The proportions were such that an equal percentage of each size was used in the experiments. The voids ranged from 29 to 45%; the grade having particles of all sizes present being the lowest in voids.

It is a well known fact that the larger the gravel in a graded mixture, the denser the concrete, and it has been determined that a concrete containing graded gravel from 2½ in. to ¼ in. requires 20% less cement for the same strength than where 1-in. to ¼-in. gravel is used, and 30% less cement than where the sizes range from ½ in. to ¼ in. The coarse particles are generally the hardest. This is especially true of glacial deposits where the grinding action has resulted in pulverizing the softer rocks into fine sand. The coarse particles, having the greatest volume, displace a large proportion of the fine, affording an excess of mortar. This fact is too often neglected, although it is quite readily proved by comparative tests where graded gravel 2½ in. to ¼ in. shows a strength of from 20 to 30% greater than concrete made with 1-in. to ¼-in. particles, and the latter 15% greater strength than where ½-in. to ¼-in. particles are used.

Many of the commercial gravels contain a large percentage of sand, due to imperfect separation and excess of sand in deposits. The influence of this is very marked on the strength of the resulting concretes. Simple experiments on the work will enable one to determine the best mixtures possible for any given material at hand. Proportioning by voids can readily be made and the proper amount of sand and cement arrived at with considerable accuracy. Should a specified proportion of cement to the aggregate be given, the different proportions of sand and gravel can be determined for maximum density, and the proportion determined that will give the least volume, which, in turn, will give the strongest concrete.

INCREASE IN HIGHWAY CONSTRUCTION IN 1914

That remarkable progress has been made in the building of good roads throughout the United States during the past few years is proved by data recently obtained by the American Highway Association and soon to be published in the official 'Good Road Year Book' for 1915. It has been found that more than 34,000 miles of surfaced roads has been constructed during 1913 and 1914, and that during the ten-year period from 1904 to 1914 more than 96,000 miles has been completed. That this progress has been really amazing may be understood from the fact that in 1904 there was only 153,000 miles of surfaced roads of all types in the United States. That the movement is attaining momentum as it goes is proved by the fact that while the average mileage construction per year during the past ten years is 9600 miles, the total completed for 1914 exceeded 18,000 miles. The report will show that something like 30,000 miles of highway has been completed with the aid of state funds, of which over $200,000,000 has been expended. The state aid movement began in 1892 and has therefore continued for twenty-two years. Only recently has it gotten well under way, as the results accomplished for 1913 and 1914 comprise a total of 10,000 miles of state aid highways completed, or in two years' time one-third of the entire mileage constructed with the aid of state funds has been completed.

Only six states now, out of a total of forty-eight, are without state highway departments, and thirty states have granted money for road building.

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California Petroleum in 1914

By R. P. McLAUGHLIN

California produced more petroleum in 1914 than in any previous year, more than any single state has ever produced in one year, and about 40% of the total yield of the United States. The amount was about 104,033,000 bbl., valued at about $48,833,000. No entirely new fields were discovered. Production exceeded consumption every month of the year except April, which is reported to have shown a slight deficit. The total excess production, which went into storage, was about 7,000,000 bbl. Activity in drilling went cheerfully on, even in the face of overproduction and prices that are too low to return adequate profit to the producer. Even the European war, which directly affected the market for oil, failed to deter some operators from drilling new wells. Words are not at hand to describe adequately a class of men who conduct business in such a fashion. It is but fair to state that an antiquated system of leases, which require the drilling of wells whether or not they are needed, accounts for some of the wasteful development. At some time an enlightened public will doubtless forbid such a ruthless waste of material, which is limited in total amount. There were about 420 wells completed during the year. As this is the smallest number for six years past, and as the annual production has still steadily increased during that time, it is clear that development must be still further curtailed. About half of the new wells were drilled in the Midway-Sunset field. The Lost Hills and the Whittier-Fullerton fields followed next in order of activity.

Production

The condition of the various fields is indicated by the following table of approximate figures, based on nearly complete returns:

Field.	Production 1914, barrels.	Producing or completed wells.	Proved land, acres.
Coalinga	15,800,000	945	14,100
Kern River	7,073,000	1,690	6,450
McKittrick	3,865,000	278	895
Midway-Sunset	50,550,000	1,420	37,800
Lost Hills	4,855,000	231	2,620
Los Angeles	2,500,000	710	1,460
Whittier-Fullerton	14,100,000	568	3,010
Ventura	935,000	364	1,600
Santa Maria	4,355,000	225	4,470
Total	104,033,000	6,431	72,405

Collectors of oil statistics seem always to be satisfied with statement of gross amount of oil or numbers of wells. Frequently these figures are about as useful to the business man as a list showing exactly the number of nails in his office floor would be. When the price of oil varies from 35c. to $1 per barrel, depending upon its gravity, it seems strange none of the statistics published by marketing companies show anything as to amounts of various grades produced or stored. Cost of production and financial results are seldom dealt with in statistical accounts. With such common omissions of useful matter it may not be necessary to apologize for here presenting some original 1913 figures in a summary of the year 1914. The figures are from *Bulletin* 69, California State Mining Bureau, which is at present in press. Financial and operating conditions have changed but little since the figures were compiled, and they probably show something of what may be expected for 1914.

Accuracy of Statistics

To those not familiar with the difficulty in gathering information on financial and operating conditions it may be well to state that the obtaining of absolutely accurate figures is an impossibility; however, several separate sources of information have here been consulted and the figures are believed to be fairly representative. Only producing companies (totaling 276) were considered. There are some 800 incorporated oil companies in the state, but many have never been active. Capital, as shown by the figures, is not definite, but the figures are intended to include all payments for stock. The cash column is probably fairly accurate, but that showing property is probably a great deal too large. Dividends, as shown, are certainly not overestimated. They roughly indicate the profitableness of the business, but it must be borne in mind that many prosperous concerns reinvest their profits without paying dividends, which probably explains the fact that prices and operating costs appear to vary so slightly between dividend and non-dividend companies. Price of oil, as shown by these figures, clearly demonstrates that only in exceptional cases is oil production profitable when less than 40c. per bbl. is received. Operating cost is here so tabulated as to bring out the operating difference between fields, in the column of cost per well per day. This method of comparing costs is the only way for an operator to determine whether costs are reasonable. A little thought given to the subject will show the absurdity of the customary quotation of costs at only per barrel produced. Two properties might be equally well managed, but if one had very productive wells and the other only small producers, cost figures per barrel would show only the difference in productiveness and not the difficulty of operation nor effectiveness of management. The operating cost does not here include such fixed charges as depreciation, taxes, or insurance, but does include the drilling of new wells and overhead charges, such as officers' salaries. These cost figures are only general, and the subject is more fully treated in *Bulletin* 69, California State Mining Bureau. Marketing companies'

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statistics account for most of the figures listed as miscellaneous. Comparison of the dividends and capital with those of the producing companies indicates that there is nearly an equal division of profits between the two branches of the industry, and that larger profits would be wholly justifiable in view of the hazardous nature of the business.

was entirely in keeping with the evidence presented, more than a year ago. The companies are directed to file rules and rates for carrying oil. The law is still subject to attack in the State Supreme Court; therefore, it may still be some time before definite action may be expected. What the final result will be upon the oil industry is highly problematical, but undoubtedly

FINANCIAL AND OPERATING CONDITIONS OF CALIFORNIA OILFIELDS, 1913

Field.	Under 18°B. %	Under 18°B. Price.	Over 18°B. %	Over 18°B. Price.	Average price.	Price to dividend Co.	OPERATING COSTS — All companies — Bbl. well.	All companies — Per well day.	All companies — Per bbl.	Dividend companies — Bbl. well.	Dividend companies — Per well day.	Dividend companies — Per bbl.
Coalinga	55	$0.350	45	$0.508	42.5c.	47.6	54	$10.96	14.1c.	65	$11.70	17.9c.
Kern River	100	....	..	....	32.8	32.7	13	2.64	20.2	26	2.73	9.6
Midway	38	....	62	....	49.0	52.1	69	10.89	15.6	67	11.78	18.7
Sunset	12	0.361	88	0.534	35.2	50.0	50	10.29	20.4	..	....	28.5
McKittrick, Belridge, and Lost Hills	25	....	75	....	47.0	45.7	63	6.87	10.9	65	6.24	9.5
Santa Maria, Lompoc, and Summerland	14	0.379	86	0.560	53.5	44.5	40	4.65	11.6	50	5.15	10.2
Ventura county	8	0.460	92	1.060	101.0	...	10	3.63	36.5	..	....	...
Los Angeles and Orange counties	27	0.555	73	0.758	70.0	...	30	5.76	19.1	..	....	...

Field.	Companies considered	Field production, %.	Capital. Cash.	Capital. Property.	Dividends. 1909.	Co.	1910.	Co.	1911.	Co.	1912.	Co.	1913.	Co.
Coalinga	59	63	$8,087,785	$9,634,512	$1,287,244	17	$1,366,243	16	$1,236,338	14	$1,154,328	15	$956,098	17
Kern River	50	42	5,198,416	3,520,029	1,123,129	22	392,472	24	389,822	22	454,095	26	361,444	19
Midway	59	48	3,891,763	12,110,051	101,000	4	562,763	10	1,076,285	18	1,128,161	19	520,520	14
Sunset	22	35	1,046,297	5,716,563	21,527	3	127,212	5	211,339	7	319,220	7	91,936	3
McKittrick, Belridge, and Lost Hills	14	54	794,859	8,164,292	269,795	2	239,750	2	85,000	1	134,945	2	538,744	6
Santa Maria, Lompoc, and Summerland	12	33	2,454,943	19,613,135	894,125	4	1,548,236	5	1,000,141	5	374,720	6	500,976	8
Ventura county	21	73	1,016,254	4,550,464	11,790	1	22,067	1	46,252	..	26,393	2	54,720	2
Los Angeles and Orange counties	27	39	4,247,826	7,329,343	1,203,556	12	1,427,908	13	1,288,034	12	878,478	12	3,015,159	14
Sub total	264	85	$26,738,143	$70,638,389	$4,912,166	65	$5,686,651	76	$5,333,211	79	$4,470,340	89	$6,039,597	83
Miscellaneous, including marketing companies	12	..	68,134,840	47,892,543	10,440,331	6	2,981,598	6	2,830,403	5	4,401,218	7	9,509,009	8
Grand total	276	85	$94,872,983	$118,530,932	$15,352,497	71	$8,668,249	82	$8,163,614	84	$8,871,558	96	$15,548,606	91

Among important features of the oil business during the year, the European war has, of course, been most prominent. For some time after hostilities began, San Francisco harbor contained many idle tankers under foreign flags, and even after this phase of trouble was eliminated many markets of fuel oil were destroyed, among them being the copper mines and smelters and the Chilean nitrate mines. Shipments of oil from the fields decreased about 15% after August. Another effect of the war was to suspend several large deals involving California oil properties. The largest transaction thus supended included the Union Oil Co. and the General Petroleum Co., which were under option to English investors. It is currently reported that the Union Oil option has been extended gratuitously. Construction of the Valley Pipe Line from Coalinga to Martinez has not been appreciably delayed by the war, which is particularly surprising as it is backed by the Dutch-Shell interests, whose headquarters are in Europe.

The decision of the Railroad Commission of California that, under the law, all the pipe-lines from the San Joaquin fields are common carriers was not unexpected, and

some very interesting facts are about to become the property of the public.

Final decision has not been made by Congress or the U. S. Land Office as to who is to own and control considerable tracts of land in the Midway field claimed by the United States government. The Secretary of the Interior offers contracts to operators, on disputed land, who were drilling prior to October 3, 1910, or were producing prior to August 25, 1914. The contracts specify that patent to the land must be applied for and then the operator may dispose of the oil if one-eighth of the proceeds is deposited in a national bank, to be paid as royalty to the government in case the patent does not issue. The United States District Court did not sustain the presidential withdrawal of some 3,000,000 acres of land on September 27, 1909. There was a later withdrawal authorized by Congress, and upon it future disposal of lands by leasing must rest, and there are close questions of title, where claimants to patent had done some work before the withdrawal. Litigation over oil lands, held under grants from the Government to railroads, indicate that the exception or

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reservation of mineral lands in such grants is invalid. Oil has also been decided to be a mineral in the legal sense.

Water damage has been the subject of considerable investigation during the past year. At Coalinga many companies are successfully operating under an agreement to arbitrate differences as to damage from water. In the Midway-Sunset field an association of operators gathers information and advises owners of wells as to the best method of shutting off water. Strenuous attempts will be made this year to have a state law which will enable operators to act to a better advantage.

The Independent Oil Producers' Agency has had a large staff of engineers appraising its property. The Agency is composed of about 165 companies, united, under agreement, to market their product. Most of the companies are situated in the San Joaquin fields, and produce heavy oil. The organization is unique in that each company has an equal number of votes with every other in the direction of business. The appraisal is said to be the first step toward forming a single corporation. Such an effort will be watched with interest, because the Associated Oil Co. had a similar origin with results that have been unsatisfactory to the original stockholders.

Large Wells

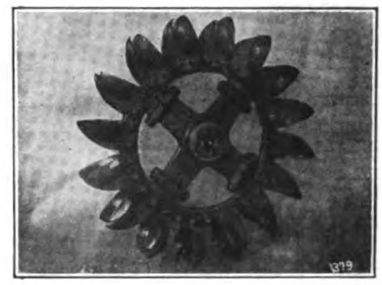
Many large wells were brought in during the year, and enumeration of them would be tiresome here. One of the most noted was that of the Lakeview No. 2 Co. in the Midway-Sunset field. It came in during May at the rate of possibly 25,000 bbl. per day, and during the next five months produced about 3,000,000 bbl. of oil. The well was so large and unruly that it caused financial loss to its owners, and will doubtless damage much of the surrounding territory with water. Accounts from reliable sources indicate that the owners were almost criminally ignorant or careless during the drilling operations and entered the oil sand without knowing the true depth of their own well. If such is the true state of affairs, they certainly merit scant sympathy, and undoubtedly such procedure is far from uncommon. In the Whittier-Fullerton field, remarkably productive wells have been brought in, where one sees orange trees uprooted to make room for the drilling rigs, even though the oil is not needed now and some of the operators will lose money by their activity.

An important advance has recently been made in extracting gasoline from natural gas. More than a dozen compressing and refrigerating plants are now in operation, with an estimated daily production of possibly 20,000 gal. Gasoline prices are the lowest in several years. The outlook for 1915 is not particularly encouraging. There will undoubtedly be the same stupendous production, wasteful methods, and inadequate profits to producers. Prophecy as to when all interests will cooperate, either with or without governmental aid, would be extremely hazardous, although the time is surely coming when such will be the case.

Industrial Progress

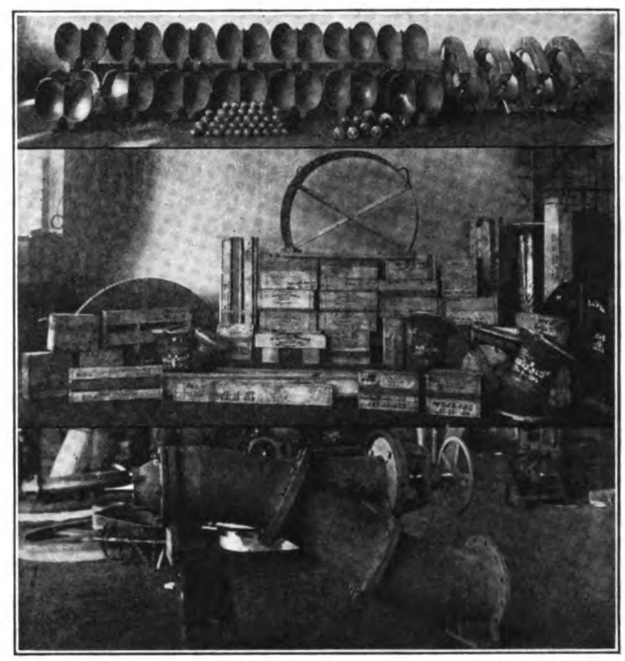
SECTIONALIZED WATER-WHEEL

In view of the many comments at the present time with reference to packing for export, it is interesting to observe how one American firm meets exceptional conditions. The accompanying illustration shows a shipment of a tangential water-wheel, made by the San Francisco shops of the Pelton Water Wheel Co., to the Estaca Mining Co. of Mexico. The wheel is a 100-hp. unit for direct connection to an air-compressor. It was necessary to sectionalize the entire shipment for mule-back transportation.



THE RUNNER ASSEMBLED.

The small halftone shows the Pelton-Doble runner assembled; the top one of the other halftone shows it taken down for packing; the bottom one shows the reverse curve needle nozzle assembled; the method of sectionalizing being plainly shown; and the middle one shows the entire equipment boxed ready for shipment.



ILLUSTRATING HOW TO PACK A SECTIONALIZED WATER-WHEEL.

Each package is properly numbered; the gross and net weight in pounds and kilograms, the cubic capacity plainly marked, and the purchaser's private mark properly displayed. These illustrations are well worth the study of any firm interested in foreign trade, while purchasers of equipment can take this shipment as a model on which to base specifications. All parts are carefully marked to place before knocking down, in order to facilitate reassembly after arrival at the mine.

It is safe to say that not only is the trade of the Company itself benefited by such careful methods of packing and shipping, but also the general reputation of the products and manufactures of the United States in Spanish-American countries is enhanced.

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THE COLLINS VISCOSIMETER

A viscosimeter that should be of great value to the oil transportation companies and others, has recently been invented by Arthur L. Collins, consulting engineer, Sheldon building, San Francisco. While there have been about fifteen viscosimeters patented, and four different types are in use

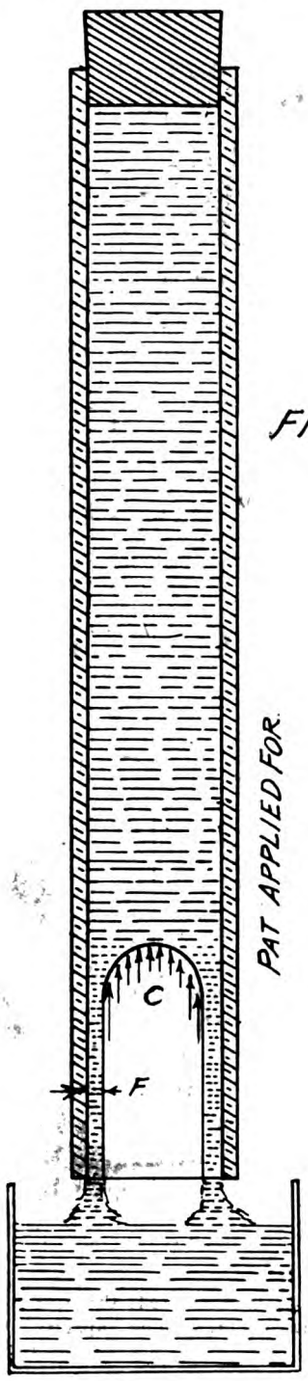

FIG. 1.

PAT APPLIED FOR.

at the present time, it is well known among petroleum engineers that the viscosity of an oil as usually obtained gives little idea as to its behavior in a pipe-line. Consequently, pipe-line construction has proceeded more or less by rule of thumb methods, despite the fact that it is a question involving many million dollars. A comparatively small increase in the operative efficiency of a line would result in a large cash saving. Any instrument which promises to furnish a method of predicting the behavior, even in part, of oils of varying gravity and composition when pumped through a pipe-line, is necessarily a matter of interest to every oil man, whether directly interested in transportation or not.

The principles of the instrument are easily conceived and

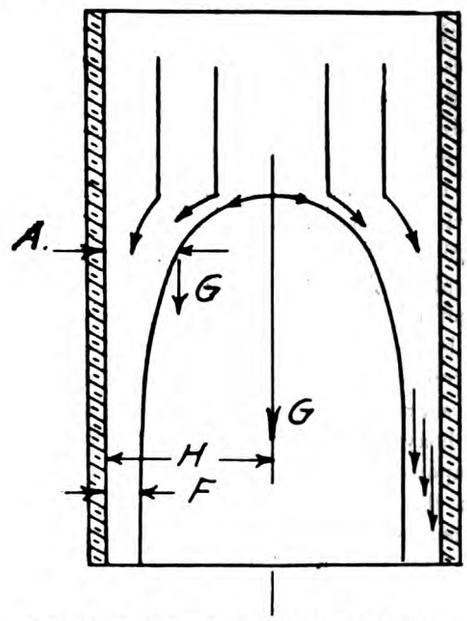

FIG. 2. SKETCH ILLUSTRATING PRINCIPLE.

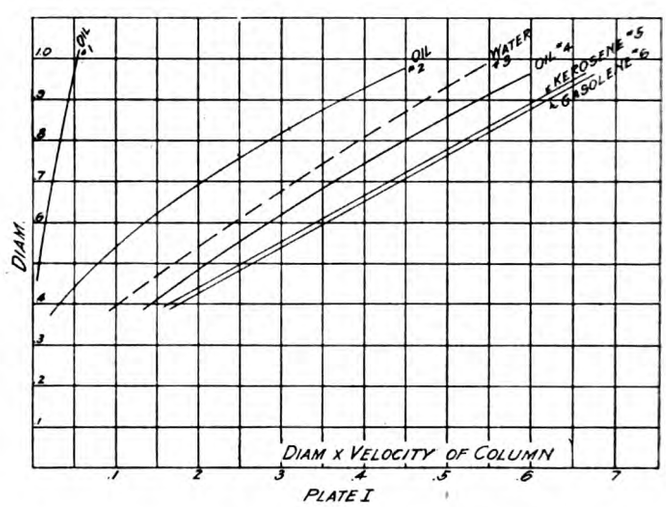

PLATE I

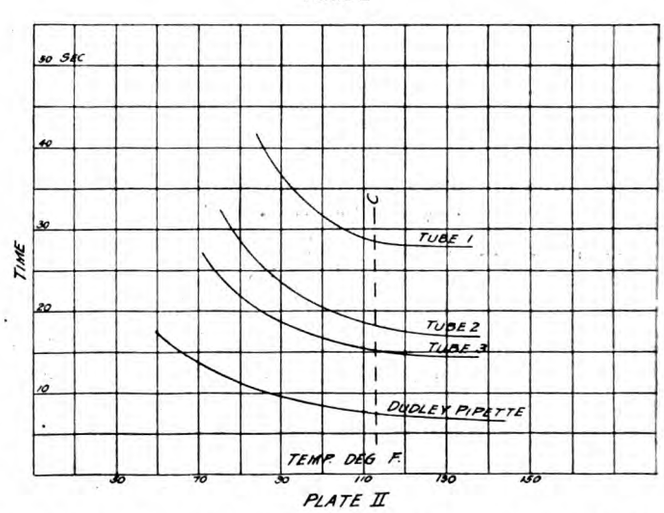

PLATE II

analyzed. Take a tube, as in Fig. 1, and, placing a cork in the bottom, fill with water, leaving the top open. When the tube is inverted, the liquid will run out in a layer along the sur-

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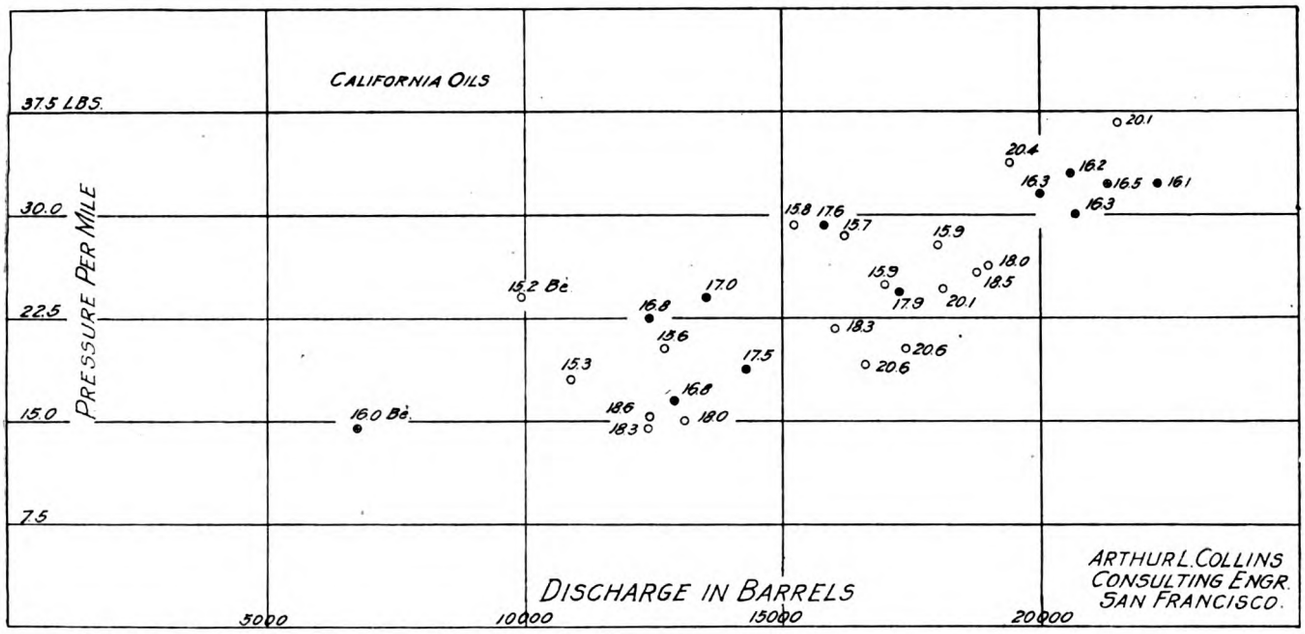


PLATE III

face of the tube, with a steady rising of the air column *C*. In Fig. 2, the action is analyzed. *G* represents the force of the liquid acting downward. There is a transverse force, for example at *A*, due to the adhesiveness of the liquid to the surface of the tube. The two forces cause the liquid to move along the inside of the tube. This action is not affected by varying the head or the velocity. The rate at which the inside column rises can be measured accurately and may be taken as the relative value of the viscosity between different liquids.

The use of the instrument is not confined to the reading taken on one tube of a given diameter. The velocity of the rising column will vary with the diameter of the tube, the larger the tube the greater the velocity of the column. It has been ascertained that the larger the tube, the thicker the film *F*. The portion of the liquid near the centre of the tube travels a greater distance, *H*.

Plate I shows the result of experiments on a series of brass tubes with ordinates of diameter and abscissae of velocity multiplied by the diameter. The curves of liquids tested in this manner will lie between that for oil, No. 1, and gasoline, No. 6. It should be mentioned that the system of platting the results is arbitrary. It was found that by multiplying the velocity of the column by the diameter of the tube used, the resulting curve for thin liquids approached a straight line, and this consideration of utility was what determined the system of plotting.

Plate II gives the results of testing an oil in a Dudley pipette, such as is frequently used in pipe-line work, and in three different sized tubes of a Collins viscosimeter. The dash line *C* may be taken as the critical temperature of the liquid. Tube 1 was the smallest, and there was consequently a tendency to exaggerate the critical temperature of the oil in this case.

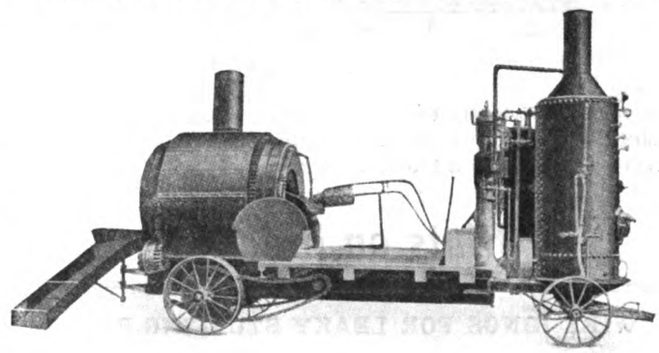
Plate III gives the actual pressure drop recorded on an 8-in. pipe-line, working under normal conditions. The figures adjoining the small circles show the gravity of the oil in degrees Baumé. A comparison of these gravities shows that they have no well defined relation to the friction losses. Two oils of the same gravity, but from different fields, may show entirely different curves. Besides being of value in the testing of lubricating oils, the Collins viscosimeter can be used in pipe-line work by plotting curves such as are shown in Plate II and determining the critical temperature of an oil therefrom.

THE RAPID HEATED MIXER

The Rapid Heated Mixer, a portable asphalt plant that has been extensively used in the East for the past four years, has made its appearance on this coast in the hands of the Edward R. Bacon Company.

This machine has several unique features. It is self-propelling, is end discharging, and is equipped with a heating plant that is new enough to warrant mention. This function of the machine is performed by two units that are separate and distinct.

The first unit is a powerful oil-burning torch that is used



THE RAPID HEATED MIXER.

to dry and heat the mineral aggregate before the asphalt is added. This torch throws a white hot flame through which the aggregate is sprayed by the mixing action of the drum. The manufacturers claim that as short a time as two minutes is sufficient to dry and heat twelve cubic feet of Topeka Specification mix to 300° Fahrenheit.

After heating the mineral aggregate, the torch is removed and the second unit holds the heat in the batch during the time of mixing the asphalt with the aggregate. This second unit consists of a fire-box underneath the mixing drum, the heat from which is conducted around the drum by a jacket which terminates in a smoke stack at the top. This fire-box has 6½ ft. of grate surface, about that of a 30-hp. boiler, and will develop sufficient heat in the mixing drum to bring 12 cu. ft. of our local bituminous rock up to 350° in ten minutes without using the torch.

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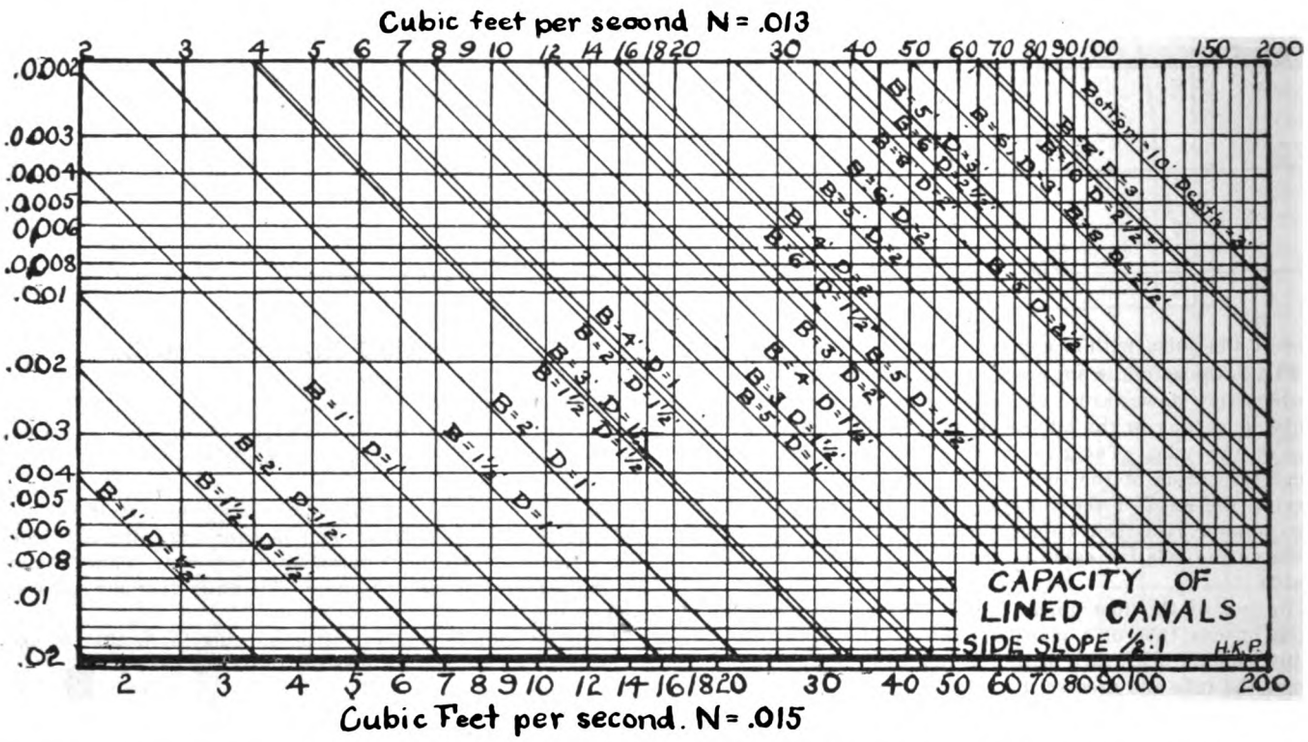
Engineers' Note Book

DIAGRAM FOR COMPUTING THE CAPACITY OF LINED CANALS

By H. K. Palmer*

The accompanying diagram shows at a glance the approximate capacity of lined canals for various sizes and slopes. As no account is taken of the variation of c in the formula, $v = c\sqrt{rs}$ with the change of slope, the results are not absolutely accurate. For most purposes, however, the diagram will be found sufficiently exact. Any other canal section may be added by computing the capacity for one slope and through that point drawing a line at an angle of 45° with the vertical.



Hints on Practice

WIRE RINGS FOR LEAKY STUFFING-BOXES

Many engineers find it impossible to prevent steam and water from blowing by the piston-rod and valve-stems of an engine, due to the fact that the rods become worn and give too much clearance space around the rod in the bottom of the stuffing-box, and also at the bore of the packing gland. The result is that the packing will work up into the cylinder or by the packing gland.

To close up this clearance many engineers make, or have made, a ring of babbitt or brass to fit the bottom of the stuffing-box next to the packing gland. A writer in *International Marine Engineering* has found that these rings take up too much space in the stuffing-box, so that it is impossible to get a sufficient number of packing rings in the stuffing-box to make a tight job; but if a ring made of No. 5 or 6 B. & S. gage copper wire is worked out to a good fit around the rod, this ring does not take up nearly as much space as a ring of babbitt or brass.

These rings are made in halves, and a small hole is drilled in each half of the ring. This is to keep the ring in place; while the packing is being placed in the stuffing-box, the two halves of the ring are fastened together with small wires. After placing them around the rod, the wire ring is taken up by filing away at the two joints. The writer has had a set of these rings in use for the past two years, and finds that they work satisfactorily in every respect.

There is another point about this arrangement which is important. When the rings are made in two parts they are kept in shape when placing them over the rod, whereas when the ring is made with only a single joint it has to be sprung over the rod, and will not make a tight fit around the rod on account of its being pulled out of shape.—*Mechanical World.*

MOVING A STEAM-SHOVEL UP AND DOWN GRADES

In moving a steam-shovel any distance across country, especially where grades are encountered, it is safe to say that it takes twice as long with the boom up as with the boom down. When you attempt to move the shovel with the boom up, the centre of gravity is high, and when there is any settling or unevenness of the track, there is a great likelihood that the shovel will turn over. With the boom down, on the other hand, there is a better distribution of the weight, consequently less blocking is required under the track, and it is not necessary to shim the track so carefully, as it does not have to be so level in order to make conditions safe.

The best way is to drop the boom on a truck or on a four or five-yard car, having the centre of the boom supported on the truck or car. The end of the boom, of course, is meanwhile resting on the boom step. Tie the boom to the circle with chains running from the circle brace clevises to the clevises on the side of the boom; take the hoisting chain off the drum and drop it on the circle; take out the front car coupler so as to get a clear lead ahead; then run a cable on the drum and lead the cable ahead. A stake or stump will pull out with much ease, consequently the end of the cable

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should me made fast to a 'dead-man.' This should preferably be a heavy piece of timber 10 to 12 ft. long, dropped into a pit dug for it at right angles to the direction in which the shovel is traveling. A ditch should be dug out of the pit leading toward the shovel, so as to provide clearance for the cable which is attached to the centre of the timber. The timber is held in the pit by driving rails or pieces of timbers crosswise over it into the sides of the pit. The dipper and handle may either be hauled independently in a wagon by horses, or in a truck attached to the end of the shovel. This last method is the more satisfactory, as the loading process is easier.

In going downhill, the cable may be led under the shovel and anchored, as before, to a 'dead-man.' The shovel may then be lowered under perfect control by simply manipulating the hoisting brake.

In climbing over steep short hills it has been found more satisfactory to use the hoisting chain instead of the cable, because in cases such as this, the strain is often too great for an ordinary sized cable.—*Excavating Engineer.*

Book Reviews

USE OF WATER IN IRRIGATION. By Samuel Fortier. P. 257. Index. McGraw-Hill Book Co., Inc., New York. For sale by *Mining Press*, San Francisco. Price, $2.

Readers of the publications of the Department of Agriculture are familiar with the many bulletins by Mr. Fortier on this same general subject. The gist of the more important among these, together with a large amount of new material is given in the present volume. It deals with the treatment of irrigating water after it has been delivered to the individual farmer, other problems connected with irrigation being touched upon only incidentally. Moisture in soils, the preparation of land for irrigation, prevention of seepage, systems of irrigation as applied to the various staple crops, as well as many other problems that confront the irrigator are fully discussed. The book will be of great value to anyone interested in irrigation, particularly the farmer himself, and a thorough perusal by every new farmer in an irrigated district might prevent some of the failures due to ignorance of conditions, now all too frequent.

A TEXT-BOOK OF GENERAL PHYSICS. By J. A. Culler. P. 311. Index. J. B. Lippincott Co., Philadelphia. For sale by *Mining Press*, San Francisco. Price, $1.80.

The scope of this work is better indicated by the sub-title, 'Electricity, Electromagnetic Waves, and Sound,' as even the phenomena of light are treated under electromagnetic waves as a feature of the general subject of ether disturbance. After a summary of elementary information regarding electricity and magnetism and the units of measurement, battery cells, galvanometers, condensers, and the measurement of electrical resistance are discussed in turn. Electromagnetic induction, including direct and alternating current motors, is then briefly considered. A general discussion of the principal phenomena of electromagnetic waves follows, and the last chapter of the book is devoted to sound.

CONSTRUCTION OF MASONRY DAMS. By Chester W. Smith. P. 272. Index. McGraw-Hill Book Co., Inc., New York. For sale by *Mining Press*, San Francisco. Price, $3.

While there is an abundance of literature on the subject of the design of masonry dams, comparatively little information is available concerning their construction. The present volume takes up this question thoroughly and in considerable detail. Starting with the exploration of the site by borings, the various construction features are taken up, including stream diversion, preparation of the foundation, quarrying, construction of the masonry itself, and face work. A number of minor features, such as work in freezing weather, settlement, drainage, temperature stresses, and ice thrust, are also considered. Considerable space is devoted to transporting and crushing machinery, and the choice of a power plant, including also a large amount of actual cost data on both installation and operation. A chapter is devoted to estimates of cost, taking up the different elements of cost in a completed project. The final chapter contains a list of many of the most important dams in existence, together with a great deal of cost data and other information concerning them.

ELEMENTS OF HYDRAULICS. By S. E. Slocum. P. 290. Index. McGraw-Hill Book Co., Inc., New York. For sale by *Mining Press*, San Francisco. Price, $2.50.

The first two parts of the book deal with the usual questions of hydrostatics and with the flow of water through orifices and over weirs, and in pipes and channels. Section III takes up impulse wheels and the various kinds of pumps and their practical applications. In the numerous exercises scattered through the book, more attention is paid to the practical application of hydraulic knowledge to actual structures than is the case with most text-books. The usual hydraulic tables are appended to the volume.

AMERICAN SEWERAGE PRACTICE. By Leonard Metcalf and Harrison P. Eddy. P. 541. Index. McGraw-Hill Book Co., Inc., New York. For sale by *Mining Press*, San Francisco. Price, $4.

The second volume of Messrs. Metcalf and Eddy's monumental treatise deals with the construction of sewers. The first chapters deal with the strictly engineering aspects of the subject, including preliminary surveys and inspection and other methods of keeping track of the work during construction. Methods and cost of all kinds of sewer excavation are considered, together with sheeting in both tunnels and open trench. The various kinds of sewer pipe and methods of laying are discussed, and the construction of larger sewers of either brick or concrete is taken up. Considerable space is given to a discussion of contracts and specifications, and standard specifications for almost every kind of sewer work are given. The rest of the book is devoted to questions of operation and maintenance, and to a discussion of explosions in sewers and their causes.

THE PANAMA CANAL. By Reuben E. Bakenhus, Harry S. Knapp, and Emory R. Johnson. P. 246. Index. John Wiley & Sons, Inc., New York. For sale by *Mining Press*, San Francisco. Price, $2.50.

The Panama canal is an interesting subject, and books concerning it have been numerous for several years. The writers of the present volume are well qualified for their task, and they have had particularly good opportunities for the collection of material. Two of them are officers in the Navy, one in the Engineers and the other in the Line. The third collaborator, who is professor of commerce and transportation at the University of Pennsylvania, contributes a chapter on the commercial importance of the canal. After a brief historical review of the project, the canal and its construction are described in non-technical phraseology. Space is then given to the sanitation problem and to the costs of the work. The next chapter is devoted to a consideration of the canal from a naval standpoint. In the chapter on the Canal and International Law, the Hay-Pauncefote treaty and other important agreements relating to the canal are discussed. The appendix contains the neutrality proclamation issued by President Wilson upon the outbreak of the European war. The book is well illustrated and there are several excellent maps both of the canal and of the surrounding country.

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Construction News Summary

Condensed From Our Daily Construction News Service.

CALIFORNIA

ALAMEDA—Board of Education has recommended expenditure of $300,000 for improvements of school system.——Recreation Commission is preparing plans for grading and drainage system in Lincoln park.

ALPAUGH—Board of Supervisors has called election for March 9 to vote on the formation of an irrigation district.

BAKERSFIELD—Contract for construction of bridge over Poso creek has been awarded to J. R. Rodgers for $4469.——Contract for grading and bridges on three miles of Lost Hills road has been awarded to C. M. Hart and M. Hart, Wasco, for $14,503.——County Clerk will receive bids until 10 a.m., March 10, for furnishing explosives for use of county highway commission.——Contract for cement walk and curbing around library has been awarded to Dulgar & Curry for $541.57.——Contract for sewers in district No. 22 has been awarded to L. S. Stroud for $4958.09.

BISHOP—Black Rock irrigation district has been formed of land in vicinity of Aberdeen schoolhouse. Milton M. Cook is a director. Water will be secured from Read Mountain Mutual Water Company.

CALEXICO—C. F. Jackson has been awarded contract for sewer on 7th street at $1.25 per foot.

CHICO—Residents of Richvale district are considering formation of drainage district covering 40,000 acres. Samuel J. Nunn is interested.——F. W. Miller will erect reinforced concrete building costing $30,000.

CHINO—F. O. Engstrum Co., 5th and Seaton streets, Los Angeles, has been awarded contract for reinforced concrete shed for American Beet Sugar Co. for $11,000.

COMPTON—Lepper & Laisy, Builders' Exchange, Los Angeles, have been awarded contract for construction of building at high school for $24,966. Contract for plumbing has been awarded to J. Hokum, 4312 Moneta avenue, Los Angeles, for $1523.

CORONADO—Board of trustees has ordered laying of 2545 ft. of 18-in. sewer on K avenue.

DINUBA—Six additional blocks of street paving are contemplated.

DUNSMUIR—California-Oregon Power Co. will lay 5000 ft. of water mains. H. S. Walther, Medford, Oregon, is general superintendent.

EAGLE ROCK—T. E. Shafer, 220 West 33rd street, Los Angeles, has been awarded contract for improving parts of Sycamore, Townsend, Forest, Park avenues, and Del Mar street at $33,986.44.

EAST SAN DIEGO—E. A. McAlpin has been awarded contract for improvements on several streets for a total of $34,362.

FRESNO—Contract for construction of garage in rear of city hall has been awarded to A. D. Wilkins for $2750.——Contract for paving F street has been awarded to Worswick company at 15½c. per square foot for paving and 1½c. per square foot for grading.——Woodhill-Hulse Electrical Co., 111 East Third street, Los Angeles, has been awarded contract for electrolier system for $36,973. Cast iron poles will be used.——S. E. Manning has been awarded contract for erection of bridge over Dry creek on Coast avenue at $2975.——At request of E. M. Prescott, who proposes to erect disposal plant, trustees will advertise for bids for franchise for collection of garbage.——Trewhitt & Shields have been awarded contract for erection of Washington school at $103,988. J. C. Hurley & Co. have been awarded contract for heating and ventilating system for $12,836.——Victor H. Gede has been awarded contract for construction of cement porch at county hospital for $513.40.——R. L. Flechlin has completed plans for two-story brick and steel hotel costing $30,000 for Mrs. Fulton Berry.——Following contracts for irrigation system in Roeding park have been awarded: To Byron Jackson Machine Works, 357 Market street, San Francisco, centrifugal pump and motor for $775; to Crane Co., 2nd and Brannan streets, San Francisco, piping for pumping station for $1744.——Winget Construction Co., 413 Grant Bdg., Los Angeles has been awarded contract for erection of State Normal School buildings at $248,641. Arthur D. Hess, 610 Baker-Detweiler Bdg., Los Angeles, was low bidder on plumbing and heating at $30,746. Thomas Haverty Co., 517 South Los Angeles street, was low bidder for steam boiler plant at $10,750.——Mountain View Improvement Association will install water system in cemetery, costing $10,000. A. L. Hobbs is president.——S. P. Walton has been awarded contract for laying two blocks of sidewalks in Courthouse park.——Louis Einstein estate will subdivide tract and spend about $20,000 on grading, sidewalks, and other improvements.

GLENDALE—J. P. Steele, 935 Chestnut street, is considering installation of cyanide plant and stamp-mill of 25 to 50 tons capacity on mining property in Arizona.——F. R. Sinclair, 221 Sinclair avenue, has been awarded contract for about 1200 lin. ft. of improvements on 8th street and on Doran street.

GLENDORA—Lacy Manufacturing Co., Washington Bdg., Los Angeles, has been awarded contract for furnishing 6 and 8-in. riveted pipe for water system. Mark-Lally Co., Palmetto and Mateo streets, Los Angeles, has been awarded contract for 2 and 4-in. standard screw pipe.

GREENVILLE—Mountain Meadow Dredging Co. will build reservoir and install dredge as soon as weather permits use of roads. R. E. Kichener, of Chicago, is interested.

GRIDLEY—A. W. Kelleher, Chico, is preparing plans for paving eleven blocks in business district, costing about $45,000.——Drainage district will be formed from land in this vicinity. J. B. Meikle, H. C. Veatch, and John Felleman are interested.——Laterals on Butte County drainage district No. 1 will be extended. E. C. Miller is engineer.

GUSTINE—J. L. Judd, county health officer, has recommended construction of sewer system.

HANFORD—City trustees have decided to pave Douty, Irwin, Harris, and Redington streets from 6th street north to city limits. Work will be done under the Vrooman act.——Board of Supervisors will finance sale of state highway bonds and construct bridges along route, insuring completion of state highway in county.

HERMOSA BEACH—Highway Construction Co., San Bernardino, has been awarded contract for about 2800 lin. ft. of concrete paving and curbing on First street and on Loma drive.——California-Arizona Construction Co., Brockman Bdg., Los Angeles, has been awarded contract for curbing and concrete paving on Loma drive, Cypress avenue, Bard street, 6th street, and Culper court.

HOLLISTER—Trustees are considering installation of electroliers on San Benito street.

HUNTINGTON BEACH—Ingersoll & French have been awarded contract for erection of one-story brick theatre for C. H. Howard.

INGLEWOOD—P. A. Thomas, Long Beach, has been awarded contract for improving Tamarack avenue for $3075.61.

LINDSAY—Several blocks of pavement will be constructed.

LONG BEACH—Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., Los Angeles, has been awarded contract for paving alleys with asphaltic cement and broken stone base, and asphaltic wearing surface at 15c. per square foot.——Bent Bros. Construction Co. has been awarded contract for erecting reinforced concrete sewage-treatment house.——City engineer Dupuy is preparing plans for reinforced concrete bulkhead to replace sea-wall damaged by recent storms.

LOS ANGELES—Contract for installation of lighting fixtures for new Southern Pacific depot has been awarded to Mayberg Co., 631 South Grand street.——San Pedro, Los Angeles & Salt Lake railroad will construct concrete depot costing $260,000.——Contract for improvement of East 7th street, Wilmington, has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., for $129,368.24.——A. L. McCray has been awarded contract for improvement of Mission road at $56,547.36.——Following contracts have been awarded by the U. S. Engineer Office for the concrete-mixing plant at San Pedro: To Smith-Booth-Usher Co., 228 Central avenue, for Bremer concrete mixer; to Parrott & Co., 320 California street, San Francisco, for track; to Edward R. Bacon Co., 51 Minna street, San Francisco for hoist and elevator; to N. B. Livermore Co., Merchants National Bank Bdg., San Francisco, for track and switches.——Standard American Dredging Co., Central Bdg., has been awarded contract for dredging the east channel in harbor near municipal dock No. 1, 210,000 cu. yd. for $39,648.——City Council has requested public utilities commission to prepare plans for subway in business district.——Contract for sewage-disposal plant at East Wilmington has been awarded to Los Angeles Planing Mill Co., 1800 Industral street, for $4237.——G. T. McLain, 4902 Sunset boulevard, has been awarded contract for improving Avenue 22 for $924.29.——Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., has been awarded contract for improving West First street at $32,002.32.——Wm. Liddington, 420 East 60th tstreet, has been awarded contract for improving Wallace avenue.——National Fireproofing Co., 322 Central Bdg., has been awarded contract for construction of one-story reinforced concrete stock house for Los Angeles Brewing Co. for $19,100.——California-Arizona Construction Co., Brockman building, has been awarded contract for improvement of Kingsley drive for $13,906.45.——Fairchild-Gilmore-Wilton Co., Pacific Electric building, has been awarded contract for paving Ardmore avenue for $5554.23.——Kling Co., Union League building, has been awarded contract for ornamental lighting posts on Harvard boulevard.——Moreland Motor Co., Wilhardt and North Main streets, has been awarded contract for furnishing fire apparatus for $22,000.——Southwestern Portland Cement Co., El Paso, Texas, will erect cement plant costing $400,000.——Following contracts have been let for sewer work: to Joe

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Chutuk, 315 S. Gless street for work in Boyle Heights district No. 1 at $1743.90; to Adam Dalmatin, 475 South Savannah street, sewer on Rosewood avenue for $1321; to B. Wucetich, 619 Casteler street, sewer in 7th street at $3410; to A. T. Brink, 1226 Exposition boulevard, sewer in Denker avenue, for $9998.85.——Bids will be received until 4 p.m., March 9, by J. P. Vroman, secretary, department of public service, Knickerbocker building, for furnishing water meters and bronze water meter connections.——Contract for erection of reinforced concrete building for Morningside school district has been awarded to George C. Condon, C. Wesley Roberts building, for $31,900.——Cass-Smurr-Damerel Co., 412 South Broadway, has been awarded contract for heating and ventilating in Compton high school buildings for $5125.——White & Gaskill, Long Beach, have been awarded contract for road improvements in district No. 41 for $16,000.——Joe Chutuk, 315 South Gless street, has been awarded contract for sewer on Arlington avenue at $822.90. John Sutalo, 844 North Beaudry avenue, has been awarded contract for sewer on F street for $866, on 59th street for $837, on G street for $937, and on Gaffey street for $587.——Fairchild-Gilmore-Wilton Co., Pacific Electric building, has been awarded contract for improving Commonwealth avenue, at $26,242.41; also for improving College street at $42,933.70; also contract for improving Bonnie Brae street, at $14,809.92.——Mlagenovich & Gillespie, 3920 Wisconsin street, have been awarded contract for sewer on Brooklyn avenue, at $2890.——John Sutalo, 844 North Beaudry avenue, has been awarded contract for sewer on Figueroa street at $14,169.——R. A. Wattson, 4907 Melrose avenue, has been awarded contract for sewer on Vine street, at $9267.50.——F. O. Engstrum Co., 5th and Seaton streets, has been awarded contract for erection of Cienega school for $34,593.——California-Arizona Construction Co. has been awarded contract for asphalt concrete paving, cement curb, and sidewalk on Mariposa avenue for $7524.67.—Charles T. Salata, 1544 Third street, Santa Monica, has been awarded contract for grading, macadam paving, and reinforced concrete culverts in road district No. 42 for $23,455.——R. H. McCray, 234 West 28th street, has been awarded contract for road improvements in district No. 58 for $10,678.——California Ornamental Brick Co., 2519 McPherson street, has been awarded contract for supplying ornamental stone work for Avenue 43 bridge at $2452.——Pacific Sewer Pipe Co., 825 East 7th street, has been awarded contract by J. W. Robinson Co. for furnishing 300,000 ornamental brick.

MARYSVILLE—City engineer W. M. Meek has reported that park improvements at Ellis lake will cost $28,599.27.

MODESTO—W. H. Worswick, Jr., was low bidder for construction of Laurel Street bridge, at $1577. Contract has not yet been awarded because of injunction suit.——Contract for construction of trestle across McGinn creek near La Grange has been awarded to Pacific Construction Co., Fresno, for $5893.——Property owners on certain streets are considering installation of electroliers. W. I. Carpenter is city electrician.

NICOLAUS—Bonds for $500,000 for system of levees were approved by voters of reclamation district No. 1001.

OAKDALE—Oakdale irrigation district will spend $300,000 on extension to system.

OAKLAND—Hutchinson Co., 13th and Franklin streets, has been awarded contract for improvement of Peralta avenue and of 35th avenue.——Heafy & Tobin have been awarded contract for construction of sewer in Brann street.——Fourteen-story building, costing $600,000, will be erected at 14th and Franklin streets. Carl Werner, Phelan building, San Francisco, is architect.

OROVILLE—City engineer has been instructed to prepare plans for paving on Bird street and on Montgomery street. Warrenite on cement base will be used on Bird street.——Contract for reinforced concrete work on canals of Feather River Canal Co. has been awarded to Chico Construction Co., Chico, for about $25,000.——Contract for dredging on Feather River canal extension has been awarded to T. K. Beard, Modesto.

PASADENA—J. C. Kinsman, 372 North Fair Oaks avenue, has been awarded contract for constructing 2500 sq. ft. cement sidewalk on Galena avenue for 8¾c. per square foot.

PATTERSON—Railroad to magnesite mines on Red mountain is being considered. James J. Cummings, 2165 East 27th street, Oakland, is interested.

PORTERSVILLE—Plans are being considered for electrolier system. Joseph Richardson is interested.——Contract for paving on 33 blocks of streets has been awarded to Federal Construction Co., Sharon building, San Francisco, at $0.1283 per sq. ft., including grading.——Property owners between here and Lindsay are considering construction of boulevard costing $100,000. Supervisor Horbach is interested.

PUENTE—C. H. Brown, 515 Stimson building, Los Angeles, is preparing plans for high school buildings costing $48,000.

QUINCY—Standard Mining Co. will construct large concrete debris dam on Nelson creek.

REDWOOD CITY—Board of Supervisors has asked for bids for construction of road from Hillsborough to Spring Valley lakes.

RICHMOND—Contract for paving 16th street from Ohio to Potrero with asphalt has been awarded to G. W. Cushing, 420 Macdonald avenue, for $19,309.33.——City engineer Chapman has prepared plans for sewers in Bay View Park district and in Meeker and in Herman additions.——All bids for dredging 6-ft. channel in south channel, San Pablo bay, were rejected and new specifications will be prepared, calling for 8-ft. channel.——City engineer Chapman has completed plans for sewer and promenade in Bay Shore tract. Total cost, $7000.——Jones & McGovern, Berkeley, have been awarded contract for erection of new Southern Pacific depot at $11,000.

RIVERSIDE—Conner Contracting Co., 709 Higgins building, Los Angeles, has been awarded contract for construction of Beaumont-Banning road at $11,361.10.

ROSEVILLE—Contract for construction of two-story pressed brick building for high school has been awarded to O'Rourke & Brady for $39,550.

SACRAMENTO—Charles Gilman Hyde, of Berkeley, and G. H. Wilhelm have been retained by city to report on proposed water and sewer system.——City commissioners have decided to install water chlorination plant costing $3000.——E. Hook has been awarded contract for erection of tile and concrete residence for David Wasserman for $29,775.——A. Trabino has been awarded contract for 34,000 sq. ft. of cement sidewalk for North Sacramento Land Co.——Bids will be received until noon, March 15, by W. F. McClure, Forum building, for construction of drives and walks, at Home for Blind, Oakland. Bids will also be received until noon, March 16, for erection of model rural school at Normal School at Chico. Bids will also be received until noon, March 17, for erection of amusement hall and library at Veterans' Home at Yountville. Plans and specifications from State Department of Engineering, upon deposit of $5 for first construction and of $10 for each of the other two.——A. L. Da Roza has been awarded contract for improving eight blocks on E street.——Contract for construction of Oak Park fire station has been awarded to C. J. Guth.——Contract for improvement of 32nd street from B to D has been awarded to C. E. Hodson.——Contract for construction of two-story brick building costing $30,000 for Joe Lewis has been awarded to J. C. Billiard.——Contract for Chico-Nelson unit of state highway has been awarded to Whitlock & Gorrill, Hearst building, San Francisco, for $70,042.40.

SAN BERNARDINO—J. J. Walters, of Walters Construction Co., 312 E street, is in the market for trench diggers, concrete mixers, reinforcing steel, expanded metal, and other items connected with concrete building construction.——Water commissioners have ordered plans prepared for 20-in. water main along 6th street.

SAN DIEGO—Pioneer Truck Co. has been awarded contract for improving Works avenue.——John Engebretsen has been awarded contract for improving National avenue, at $14,789.——Plans have been prepared by superintendent Fay for shop buildings.——Council has appropriated $4000 for concrete bridge across Rose creek near Pacific Beach to replace wooden one damaged by recent storm.——Thomas J. Wright, Oil City, Pennsylvania, has purchased mine about 55 miles from here and will expend about $75,000 on machinery and equipment, including mill, cyanide plant, tramway, etc.——United States Cast Iron Pipe Casing Co. has been awarded contract for furnishing about 20,000 ft. of pipe to the city.——Isbell Construction Co. has been awarded contract at $4917 for improving Capley street.——Charles Julian has been awarded contract for installing Bonita avenue pipe-line.——Pioneer Truck Co. has been awarded contract for improving California, Henry, and Titus streets.

SAN FRANCISCO—Southern Pacific Co. is preparing plans for deep water terminal on Channel street costing about $2,500,000.——L. A. Norris Co. will erect building at Sutter and Jones streets, costing $150,000.——E. M. Chadbourne has been awarded contract for asphalt wearing surface at exposition site, for $7300.——James L. McLaughlin, 244 Kearny street, has been awarded contract for erection of 6-story class C reinforced concrete building for W. A. Rudgear, for $82,000.——Marcus Marcussen, Royal Insurance building, has been awarded contract for erection of 3-story class C apartment building for A. Rothberg, for $39,364.——Western Building & Engineering Co., Phelan building, has been awarded contract for erection of exhibit building for Republic of Panama for $14,993.——Williams Bros. & Henderson, Holbrook building, have been awarded contract for erection of 7-story, class A apartment house for S. W. Morshead for $134,911.——Board of State Harbor Commissioners have awarded contract for construction of Wells Fargo & Co. Express building at foot of Mission street to Fred L. Hansen, Sutter and Taylor streets, for $38,946. Daniel Contracting Co., 503 Market street, has been awarded contract for furnishing 1000 tons of rubble rock.——Board of Supervisors has adopted plan No. 9 for Church Street Municipal railroad. This will require expenditure in excess of bond issue. Method of raising additional amount has not yet been determined.——Board of Public Works has granted permission for following street improvements by private contract: by Blanchard-Brown Co., 660 Market street, im-

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provement of 21st avenue and of Rivera street; by Fay Improvement Co., Phelan building, paving on Beach street; by H. G. Vaughan, Foxcroft building, sewer on Amazon avenue; by Flinn & Treacy, First National Bank building, paving on Lower Terrace; by Owen McHugh, 321 Bush street, curbs and paving on Holloway avenue; by J. F. Dowling & Co., Russ building, curbs and paving on Plymouth avenue.——Peter Windeler Co., 2033 Howard street, has awarded contract to Fred Miller for erection of 6-story class C apartment building, for $80,106. ——City engineer M. M. O'Shaughnessy has been requested to prepare preliminary plans for subway crossing Market street at several points.

SAN GABRIEL—E. J. Denman, 1614 West 47th street, Los Angeles, has been awarded contract for construction of reinforced concrete culvert for $4295.——Contract for erection of hollow tile school buildings has been awarded to John Harnish Co., 516 Stimson building, Los Angeles.

SANGER—Plans are being prepared for asphalt pavement on six blocks in business district and oil macadam on several other streets.

SAN JOSE—John Stock Sons have been awarded contract for furnishing 1200 ft. of 2-in. pipe.——Improvements have been ordered on Park avenue, Hobson street, and Oak street.——City engineer M. Maggini will prepare plans and specifications for paving 24 streets in various parts of the city.——Property owners east of city are considering plans for drainage district. A. Kammarer and E. Spicer are interested.——Improvements on Hull avenue consisting of grading, graveling, and constructfon of concrete curbs and gutters have been ordered.——Improvements, including 4-in. concrete base and 1½-in. asphaltic concrete wearing surface, concrete curbs and gutters, and brick catch basins, have been ordered on San Carlos street from Delmas avenue to city limits. M. Maggini is city engineer.

SAN MATEO—Council is considering ornamental lighting system. Concrete posts will be used.

SANTA ANA—Contract for erecting two reinforced concrete bridges in Tustin road district has been awarded to W. J. German, Tustin, for $1465.——Grounard & Young have been awarded contract for erection of addition to water works building for $4931.

SANTA BARBARA—F. R. Ritchie & Co., Chronicle building, San Francisco, has been awarded contract for improvement of Hollister avenue and of Mission street, costing about $50,000.

SANTA CRUZ—City engineer has been instructed to prepare plans for 106,376 sq. ft. of concrete pavement, 388 lin. ft. of curb on Ocean and Plymouth streets.——Sewer will be constructed in Garfield Park district.——City Engineer is preparing plans for macadam pavement and sewers on King street.

SANTA ROSA—Bordwell & Zimmerman have been awarded contract for county bridges over Franz and Kelly creeks.

SOUTH PASADENA—Wattson & Spicer, Wright & Callender building, Los Angeles, have been awarded contract for constructing part of sewer system, using vitrified pipe, for $31,639.25.

STOCKTON—Chamber of Commerce is considering plans for flood protection for city and adjacent areas. F. J. Dietrich and W. G. Hunter are interested.——Moreing Bros. have been awarded following contracts: improvement of Pine street near Lodi for $4163.45; improvement of Kettleman lane for $6323; improvement of Davis road for $5221.50.

VENICE—Trustees are considering plans for bulkheads costing $100,000 to repair damage by recent storm.——H. C. Mayer has been awarded contract for construction of outfall sewer. ——C. W. Corbaley, H. W. Helman building, Los Angeles, has been awarded contract for reconstruction of Kinney pier, damaged by recent storm

WOODLAND—Landholders along Cache creek are considering formation of reclamation district. Edgar J. Depue is interested.

OREGON

ASTORIA—Washington Brick, Lime & Sewer Pipe Co., Washington and Pacific streets, Spokane, Wash., has been awarded contract for supplying sewer pipe for $20,000.

BAKER—Oregon Lumber Co. will install private electric lighting plant.

BANDON—Port commissioners have decided against purchase of dredge, but will let contract for considerable dredging work. R. H. Rosa is president of commission.

THE DALLES—Oregon-Washington Navigation & Railroad Co. will construct freight terminal costing $200,000.——George Isackson, 1013 East Irving street, Portland, has been awarded contract for construction of sandstone building for postoffice at $79,658.

ENTERPRISE—Bids will be received until March 22 by city clerk for construction of 2½ miles of sewers, and septic tank.

EUGENE—Poe & Deveraux are considering construction of logging railroad to timber lands on Lost creek.

GRANTS PASS—Contract for construction of 68-ft. wooden bridge over Taylor creek has been awarded to Albert Anderson.

GRESHAM—D. C. Ely is preparing plans for brick building costing $15,000.

HILLSBORO—Contract for about six miles of ditch in district No. 7, involving about 55,000 cu. yd. excavation, will be let during spring. George McGee is district engineer.

KLAMATH FALLS—Petition for organization of Klamath drainage district, comprising 27,385 acres, has been filed with county clerk. It is proposed to construct a series of dikes, levees, and embankments along Klamath strait and Lower Klamath lake.——Houghtaling & Dougan, Henry Bdg., Portland, are preparing plans for Elks' building, costing $50,000.

MILWAUKEE—Sewer system costing $140,000 is being considered.

PENDLETON—Carnegie library, costing $25,000, will be erected. J. W. Maloney is interested ——Western Land & Irrigation Co. has been making surveys for reservoir in Alkali canyon and canal system. W. R. Hinkle is engineer.

PORTLAND—White Motor Co. has been awarded contract for motor truck for city at $3000.——Order of Moose will erect building costing $125,000. George L. Baker, Morgan Bdg., is on building committee.——School board has directed F. A. Naramore to prepare plans for Franklin High School building, costing $100,000.——Jacobberger & Smith, Board of Trade Bdg., are preparing plans for two-story reinforced concrete building for Doernbecher Manufacturing Co.——Union Meat Co., 283 Gilson street, will make additions to plant costing $150,000.—— J. S. Winters, Couch Bdg, has been awarded contract for addition to Richmond school for $60,000.——City council is considering purchase of 5000 tons of cast iron pipe of various sizes. ——Coin Machine Manufacturing Co., Corbett Bdg., will erect factory costing $50,000.——City commissioner Dieck has completed plans for fireproofing west span of Broadway bridge at an estimated cost of $3600.——Kerr Turbine Co. has been awarded contract for turbine engines for dredge 'Columbia' by Port Commission at $13,870.——Reitze, Storey & Duffy, Northern Bank Bdg., Seattle, are preparing plans for oil distributing station costing $500,000 for Shell company of San Francisco.——Ernest Kroner, Worcester Bdg., is receiving bids for construction of Gresham High School building.——Commissioner Daly will ask for bids for 500 water meters.——City council is considering erection of plant for paving repairs costing $10,000.——Bids will be received until 4 p.m., March 10, by J. P. Doyle, assistant secretary, Port of Portland, Court House, for furnishing water-tube boilers and centrifugal circulating pump with turbine.——Following street improvements are contemplated: Gravel bitulithic pavement on East 44th and East 45th street, costing $12,160; grading, curb, and sidewalks on 22nd avenue and on East 70th street, costing $4905 ——A. W. Kutsche, Yeon Bdg., has been awarded contract for construction of reinforced concrete market building for $5500.——Jeffery & Bufton, Failing Bdg., were low bidders for paving of Front street, from Glisan to Park, at $7932.45.——Arthur D. Kern, 545 East Ash street, was low bidder for grading and sidewalks on 76th street at $9823.61.——William Lind, 525 16th street, has been awarded contract for construction of Willow-street sewer for $148,639.

RIDDLE—Neenah Oregon Land Co. will construct dam costing $6000 on South Umpqua river. DeWit Van Ostrand is president.

SPRINGFIELD—Springfield Creamery Co. will erect concrete building. Charles Berkman is president.

TILLAMOOK—Collier & Stephenson, Salem, have been awarded contract for constructing dikes for H. F. Goodspeed for 12c. per cubic yard.

UTAH

OGDEN—Joseph Scowcroft & Sons have been granted franchise for erection of steel viaduct across Wall avenue, near 23rd street.——City engineer W. Jenkins has prepared plans for 10,305 ft. of 36-in., 9520 ft. of 30-in., 8890 ft. of 24-in. wood-stave pipe, in Ogden cañon; also for 13 additional wells. Pipeline will require 26,575 cu. yd. earth excavation. Cost, about $75,000. Contract will be let in spring. Plans have also been prepared for boulevard along river, costing $100,000.——Contract for construction of building for Deaf and Blind school has been awarded to C. F. Dinsmore for $30,491. Contract for heating system has been awarded to Welshan & Atkins for $1993, and for plumbing to Halvorsen Bros. for $3513.——Davis & Weber County Canals Co. will issue bonds for $150,000 for construction of concrete arch dam in East cañon.——Directors of Ogden, Logan & Idaho Electric railway have decided to build Brigham City-Wellsville extension via Collinston.

PROVO—Reynolds-Ely Construction Co., Springville, was low bidder for construction of division 4, Strawberry Valley reclamation project, at $82,624.75.——Bids will be received until 2 p.m., March 10, at office of U. S. Reclamation Service, for construction involving about 12,800 cu. yd. excavation and 2100 cu. yd. reinforced concrete. Work is near Payson City, Utah, on the San Pedro, Los Angeles & Salt Lake railroad, and the

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Tintic branch of the Denver & Rio Grande railroad. Particulars from U. S. Reclamation Service, Provo, or Washington, D. C.

SALT LAKE CITY—City engineer Cannon has recommended the following expenditures during 1915: to complete Fifth South Street reservoir, $25,000; to complete Lake Phoebe dam, $50,000; to carry on Twin Lakes dam, $70,000; to begin excavation work on City Creek reservoir, $10,000; excavation work on dam in Parley's cañon, $25,000; main trunk sewer, 18,000 ft. long, $225,000; discharge outlet, $50,000; city's portion of sewer extension 326, $25,000.——State road engineer E. R. Morgan has recommended construction of steel bridge over Price river at Mounds, costing $5697.——Willis Polk & Co., Hobart building, San Francisco, have prepared plans for country clubhouse.——City commissioners will readvertise for bids for construction of rubble concrete dam, costing about $60,000, at Twin Lakes in Cottonwood cañon.——Utah Concrete Pipe Co. has been awarded contract for furnishing 1250 ft. of pipe for drainage system on Redwood road for $250.——City commission is receiving bids for extending surplus canal about two miles. Estimated cost, $12,000.

WASHINGTON

ABERDEEN—Pat Manning, Chehalis, has been awarded contract for erection of post-office at $9745.——Council has adopted plans for trunk sewer in western section of city. P. F. Clark is city clerk.

BELLINGHAM—County commissioners will receive bids until March 18, for construction of 380-ft. steel bridge with reinforced concrete piers. C. M. Adams is county engineer and Charles Evan Fowler, Central building, Seattle, is consulting engineer.——Fire chief E. Hofercamp recommends purchase of additional motor equipment.——Kirby Shipyards will construct steamer costing $150,000 for Bellingham-Alaska Trade & Transportation Co.——Water main costing $2000 will be laid on Walnut street.

BREMERTON—Contract for construction of buildings at Puget Sound hospital has been awarded to Bert Ward, 513 31st street, Seattle.——Oswald & Kantz are receiving bids for construction of one-story concrete theatre building costing $35,000. Max Umbrecht, Rector hotel, Seattle, is architect.

CHEHALIS—Two Miracle Concrete Co., Kalispell, Montana, has been awarded contract for construction of highways 181 and 5A for $13,600 and $14,000, respectively. Jacobsen-Bade Co., 497 Stanton street, Portland, Oregon, has been awarded contract for highway 2A at $15,458.——Contract for trestle approach to bridge at Lincoln creek has been awarded to J. S. Ryan, Toledo, for $5440.——Contract for construction of two steel bridges has been awarded to Coast Bridge Co., Railway Exchange building, Portland, for $20,409.

ELLENSBURG—Lighting superintendent Butler has recommended the installation of auxiliary steam power plant costing $65,000.

EVERETT—Council has ordered grading, cement curbs, sidewalks, and drainage on Wall street.——Bids will be received until March 22 by county commissioners for construction of 255-ft. frame trestle bridge over Allen creek.——Bids will also be received until March 15 for construction of 2½ miles of Beverly Park highway, including trestle 361 ft. long.

HOQUIAM—C. E. and R. L. Philbrick will erect two-story concrete building for postoffice, costing $18,000.——Grays Harbor port commission is having plans prepared for dock costing $75,000.

KALAMA—Contract for construction of Gabrielson Hill road has been awarded to Jeffrey & Bufton, Failing Bdg., Portland, for $3787.57.——Mountain Timber Co. will rebuild mill costing $300,000. C. Burnett, Lewis Bdg., Portland, is interested.

KELSO—M. E. Hull has been awarded contract for clearing right-of-way in diking district No. 2 for $1865.—Contract for diking and ditching has been awarded to Collier & Stevenson, Salem, Oregon, for $35,445.

KENNEWICK—Contract for construction of drainage ditches has been awarded to George P. Wright, Provident Bdg., Tacoma, for 20c. per cubic yard.

MONTESANO—County commissioners are considering plans for six highway bridges. W. C. Birdwell is county clerk.——Engineer Robertson has prepared plans for Markham-Ocosta and other roads, and bids will be called at once. Phil Locke is commissioner.

NORTH YAKIMA—All bids for pipe in drainage district No. 4 have been rejected and county engineer J. O. Greenway is preparing specifications permitting bids on cement as well as on vitrified pipe.

OKANOGAN—Contract for construction of building for First National Bank has been awarded to Bird & Hobson, Wenatchee, for $10,000.——County commissioners have appropriated $4300 for improvement of road to Omak.

OLYMPIA—Olympia National Bank will erect a class A building costing $40,000.

PORT ANGELES—Contract for graveling road from Sequim to Blyn has been awarded to Gays, Ford & Grant for $5150.

PROSSER—Contract for construction of Kennewick-Finley road has been awarded to W. A. Morain, Kennewick.

RITZVILLE—Contract for improving B street has been awarded to A. H. Zane & Co. for $1989.

SEATTLE—Bids will be received at U. S. Engineer Office, 602 Burke Bdg., until noon, March 15, for construction of pumping plant at Lake Washington Canal locks. Particulars from J. B. Cavanaugh, Major of Engineers.——Seattle & Lake Washington Waterway Co. has been awarded contract for filling old canal and for dredging East Waterway at 19c. per cubic yard.——Joshua Green Corporation has awarded contract for construction of 59 steel staterooms in steamer 'Chippewa' to Seattle Construction & Dry Dock Co., Charles street.——Neil MacDonald, Central Bdg., has been awarded contract for construction of building for Northern Life Insurance Co., costing $50,000. Contract for heating and plumbing to Norton & Smith, White Bdg. Contract for electrical work to Meacham & Babcock, Central Bdg.——Contract for brick paving in 6th avenue and Westlake avenue district has been awarded to T. Ryan, Lowman Bdg., at $69,238. Contract for brick paving on 8th avenue to T. Ryan at $5539.——Contract for Mess Bros. road has been awarded to Sloane Bros., Des Moines, Wash., at $10,107.07.——W. T. Butler Contracting Co., Central Bdg., has been awarded contract for construction of five-story addition to Fischer Bdg. at $85,000. Rautman Plumbing & Heating Co., 118 King street, has been awarded contract for plumbing and heating.——Contract for curbing and water mains on 31st avenue and other streets has been awarded to L. R. Ellis, Central Bdg., for $10,174.70.——Contract for grading and other improvements on West Stevens street has been awarded to Doyle & Keenan, 114 Harvard avenue, for $2317.40.——Pacific Board & Paper Co. will rebuild plant at Eastlake and Galer streets. J. R. Stirrat, 946 17th street, is president.——Manhattan Contracting Co., Central Bdg., has been awarded contract for construction of 14th avenue bridge for $19,475.——Novelty Iron & Wire Works, 1142 Sturges road, has been awarded contract for elevator for the grain elevator project, Port of Seattle, for $6000.——Contract for sheet metal for the Sears-Roebuck Bdg. has been awarded to Puget Sound Sheet Metal Works, Wall and Elliott streets, for $30,000.——Contract for construction of Merced Island road has been awarded to Ferch & Gass, 1426 23rd street, at $16,890.—U. S. Engineer Office has awarded contract for furnishing 35,000 tons of rock at Lone Tree, Wash., to Cascade Contract Co., Portland, Ore., at $60,550.——Port commission will erect four-story headhouse at West Seattle ferry; estimated cost, $40,000.——J. O. Taft, 2334 North 10th avenue, is preparing plans for four-story building costing $105,000 for Woodmen of the World.

SOUTH BEND—Charles B. Nims, county engineer, is receiving bids for construction of two bridges, one 84-ft. wooden span and the other alternative of a 44-ft. wooden span or 28-ft. concrete span.

SPOKANE—L. W. Hutton, Hutton Bdg., will make alterations to Fernwell Bdg., costing $20,000.——Carstens Packing Co., Tacoma, will erect packing-house costing $100,000.

TACOMA—Griffin Wheel Works, South Tacoma, has been awarded contract for furnishing lighting standards for North End lighting system for $1726.20.——Northwestern Supply Co., 707 Commercial street, has been awarded contract for regulators for $852, and Pierson-Roeding Co., Colman Bdg., Seattle, contract for cable at $1485.——County commissioners are considering plans for paving road between Orting and Alderton, about five miles; estimated cost, $50,000.——Contract for erection of Elks' Club building, costing about $100,000, has been awarded to Cornell Bros., Savage-Scofield Bdg.——Sewers will be constructed on 21st and adjacent streets; estimated cost, $1933.—Bridge inspector J. M. Hayes has advised construction of steel bridge over Marshall river, costing $15,000, in place of present structure.——City engineer Raleigh has prepared plans for sewer system for what is known as School District. Estimated cost, $20,000.——County commissioners have ordered surveys and estimates on four proposed roads.

TONASKET—Land-holders of about 3000 acres in this vicinity are considering pump irrigation project. George E. Baker and W. C. Dobbins are interested.

TUMWATER—City and county will divide cost of construction of steel and concrete bridge over Deschutes river. Estimated cost, $10,000.

WALLA WALLA—Bids will soon be received for construction of 5865 lin. ft. of 16-ft. concrete roadway with bituminous top, and for 4720 lin. ft. hard surface pavement, 34 and 45 ft. wide. W. R. Rehorn is city engineer.

WENATCHEE—William Turner is preparing plans for reinforced concrete warehouse and cold-storage plant, costing $400,000.——T. E. Young, 5047 15th street, Seattle, has been awarded contract for erection of brick and concrete school building for $15,850.——Highland canal water users have formed irrigation district. Conrad Rose is a director.

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Personal

W. S. CLARK has been appointed city engineer of Anacortes, Washington.

K. A. HERON, formerly chief engineer of the Modesto, California, irrigation district, has resigned.

J. C. VAUGHN has been elected president of the Entiat, Washington, Telephone & Telegraph Company.

JOHN M. WILLIAMSON will take up the management of the property of the Palmer Union Oil Co., succeeding FRANK L. BROWN, resigned.

A. B. FLETCHER, state highway engineer of California, has been elected second vice-president of the American Road Builders' Association.

FRED N. WALLACE, of Laidlaw, Oregon, has been appointed project engineer of the Tumalo Irrigation Project to succeed O. LAURGAARD, resigned.

CHARLES EVAN FOWLER has been retained by the county of Whatcom, Washington, as consulting engineer on several large bridges to be erected this spring.

Major HENRY C. JEWETT, of the U. S. Engineer Corps, has been ordered to report at Portland to assist Colonel MCKINSTRY in the work of the Second Oregon district.

HARRIS HAMMOND, formerly director and vice-president of the Mount Whitney Power Co., of Visalia, California, has been elected president, succeeding JOHN COFFEE HAYS.

L. F. HARZA and V. H. REINEKING have opened offices as hydro-electric consulting engineers in the Spalding building, Portland, under the name of L. F. Harza & Company.

C. K. CLARK, consulting engineer, of Los Angeles, who was formerly connected with the work of the California Development Co., has been elected city manager of Tucson, Arizona.

H. T. CORY has been awarded the Thomas Fitch Rowland prize for 1914 by the American Society of Civil Engineers for his paper on 'Irrigation and River Control in the Colorado River Delta.'

E. M. BREED, formerly Vancouver manager for the Canadian Allis-Chalmers, Ltd., has been appointed district manager of the Pelton Water Wheel Co., with headquarters at Vancouver, British Columbia.

J. B. LIPPINCOTT has been awarded the J. J. R. Croes medal for 1914 by the American Society of Civil Engineers for his paper on 'Tufa Cement as Manufactured and Used upon the Los Angeles Aqueduct.'

FULTON LANE has been appointed president of the Board of Public Utilities of the city of Los Angeles, and FRANKLIN D. HOWELL has been appointed chief engineer of the railroad department of the Board.

R. A. HART, engineer in charge of the Western Drainage Division of the Department of Agriculture, has been called to Washington for a conference with S. H. McCrory, chief of the Drainage Division.

B. F. AFFLECK has been elected president of the Universal Portland Cement Co., succeeding Edward M. Hagar, who resigned to accept the presidency of a newly formed cement company with headquarters at Chicago.

HANS MUMM, Jr., has been elected president of the Washington State Association of County Engineers; J. W. STRACK was elected first vice-president; A. P. DENTON, second vice-president; and A. L. STRONG, secretary and treasurer.

R. P. MCLAUGHLIN, of the California State Mining Bureau, with headquarters at San Francisco, has returned from a trip through the oilfields of the state, with the object of discussing the proposed water protective legislation with the oil operators.

G. W. WHITLEY was elected president of the Utah Light & Traction Co. at a meeting of the board of directors, held February 18. H. L. Beach was elected manager of the Company, the former manager, JOSEPH S. WELLS, being elected secretary and treasurer.

At a meeting of the Southern California Association of members of the American Society of Civil Engineers, held at the Clark Hotel, Los Angeles, February 10, D. L. REABURN, locating engineer for the U. S. Alaska Railway Commission, delivered an address on transportation facilities and problems.

At the regular meeting of the San Francisco association of members of the American Society of Civil Engineers, held at the Palace hotel, February 19, president A. M. HUNT delivered his inaugural address. J. C. MORROW, an architect of Melbourne, Australia, was a guest of the Association and was called upon for a few remarks. The paper of the evening, on 'The Engineering Features of the Panama-Pacific Exposition,' by A. H. MARKWART, was read by J. D. GALLOWAY, Mr. Markwart's duties in connection with the opening of the Exposition making it impossible for him to be present. Professor CHARLES D. MARX, of Stanford University, recently elected president of the national Society, was present at the meeting.

Commercial Paragraphs

Woods, Huddart & Gunn, 444 Market street, San Francisco, have arranged for the exclusive Pacific Coast agency of CROCKER BROS., of New York, handling pig irons, ferro alloys, and coke. The department will be in charge of Charles M. Gunn.

The contracting firm of WILLARD-SLATER CO., 2314 Santa Fe avenue, Los Angeles, has been dissolved by mutual consent, Mr. Slater taking over the present offices and yards under the name of the WALTER SLATER CO. R. H. Willard and E. I. Brent have formed the WILLARD-BRENT CO., with offices at 1119 Baker-Detweiler building.

THE PLATT IRON WORKS, Dayton, Ohio, has established Pacific Coast headquarters in the Rialto Bdg., San Francisco, handling Stilwell feed water heaters, Smith-Vaile pumps and compressors, and Platt centrifugal and turbine pumps. Kirk W. Eichelberger is in charge of the offices.

The hydro-electric power plant of the Mountain King Mining Co., on the Merced river near Mountain King, Mariposa county, California, was recently placed in regular operation. There is one 350-kva., 3-phase, 4000-volt generator direct driven at 600 r.p.m. by a scroll-case turbine water-wheel built by S. MORGAN SMITH CO. A transmission line 1½ miles long leads to a 30-stamp mill now in course of erection. R. W. Van Norden, Rialto Bdg., San Francisco, designed and has had supervision of the project, and J. R. Cahill, 460 Montgomery street, San Francisco, was the contractor on the work.

Catalogues Received

'Symons Disc Crusher,' CHALMERS & WILLIAMS, INC., Chicago Heights, Illinois, describes the different sizes of the Symons disc crusher.

'Rex Mixer. Bulletin No. 59.' THE CHAIN BELT COMPANY, Milwaukee, Wisconsin. Describes and gives prices of the chain belt concrete mixers manufactured by this Company.

'Ventilating the Fletcher Savings & Trust Co. Building.' THE AMERICAN BLOWER CO., Detroit, Mich. Describes installation of 'Sirocco' system of ventilating in a large office building in Indianapolis, Indiana.

'Caterpillar. Bulletin TE 40.' THE HOLT MANUFACTURING CO., Stockton, Cal. Describes these well known tractors and gives a number of records of actual performance and other testimonials.

'Centrifugal Pumps. Bulletin 19.' THE TERRY STEAM TURBINE CO., Hartford, Conn. Explains the principles of operation and construction of centrifugal pumps, as well as the details of the steam turbines which are now frequently used to drive them. A number of useful hydraulic tables are included, as well as a description of the Company's pumps and turbines.

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